NATIONALGEOGRAPHIC.COM

JANUARY 2001

NATIONAL GEOGRAPHIC

2001
THE BODY IN SPACE
SURVIVING THE ODYSSEY

Great Barrier Reef
Australia's Coral Kingdom 30

Ancient Ashkelon
Dead Men Do Tell Tales 66

Japan's Imperial Palace
First Look Inside 94

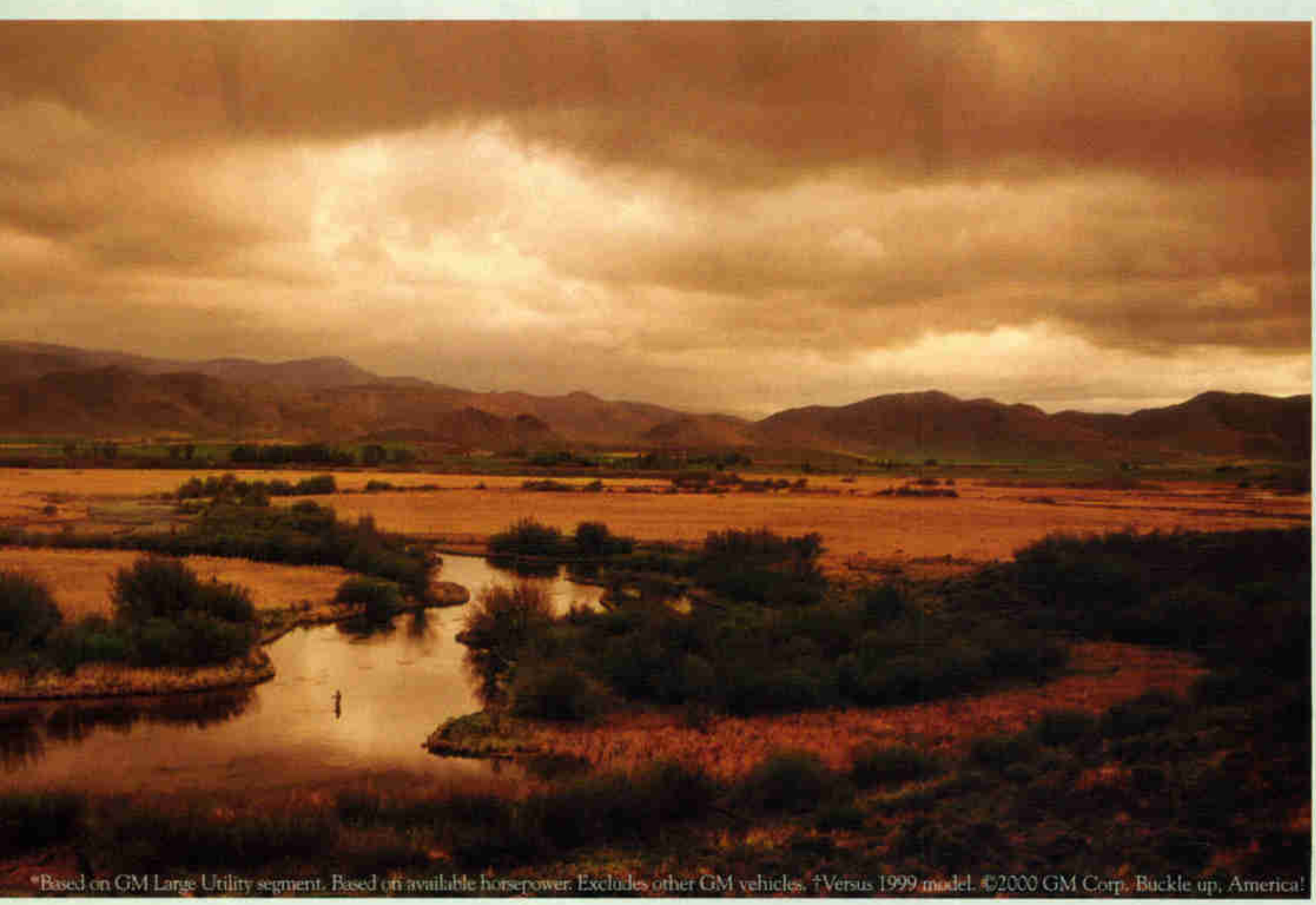
YOU ARE A MICROSCOPIC
YOU MIGHT AS WELL BE A MICRO

The Chevy™ Tahoe® has more power than ever. The advanced Vortec™ engines are among the most powerful V8s

in the awe-inspiring vastness and realize that, with your powerful new Tahoe, your position in the world has just

MORE POWER, MORE ROOM, MORE SUV!

PECK IN THE UNIVERSE.
COPIC SPECK WITH MORE POWER.



*Based on GM Large Utility segment. Based on available horsepower. Excludes other GM vehicles. †Versus 1999 model. ©2000 GM Corp. Buckle up, America!

their class.* With available Autotrac® four-wheel drive, you can use all this power to go way out there, take

sen slightly. The new Chevy Tahoe. It's nowhere near anything. Call 800-950-2438 or visit chevrolet.com

TAHOE

LIKE A ROCK

DEFENSE DEPT.

You and your family have a strong ally in the daily battle to keep your food safe. Plastic bottles, plastic wraps and plastic containers reduce the potential for food spoilage and help protect products from contamination. And, tamper-evident plastic seals provide an extra measure of product safety assurance. They're all working to keep your family's food protected from the moment it's packaged until the time it arrives home. To learn more about the benefits of plastics, contact the American Plastics Council at www.plastics.org or call 1-800-2-HELP-90.

American Plastics Council®

PLASTICS MAKE IT POSSIBLE.®

VOL. 199 • NO. 1 • JANUARY 2001

Contents

The Imperial Palace—94

FEATURES

DEPARTMENTS

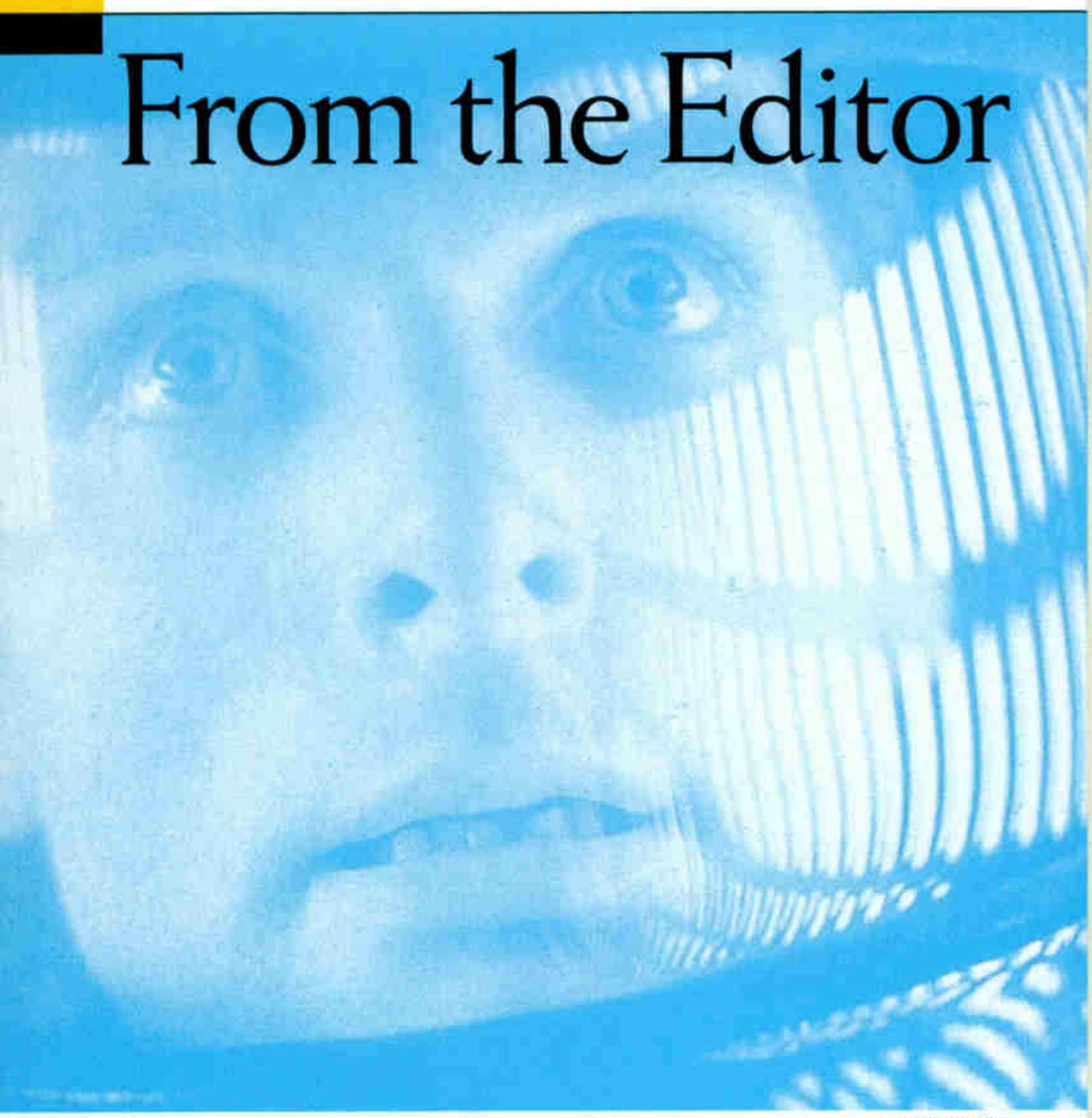
THE COVER

NASA's H-1 prototype space suit promises enhanced flexibility on future missions.
PHOTOGRAPH BY IRA BLOCK

MORE INFORMATION

MEMBERSHIP Please call **1-800-NGS-LINE (1-800-647-5463).** Special device for the hearing-impaired (TDD) **1-800-548-9797.** Online: **nationalgeographic.com/ngm**

From the Editor



JOHN JAY, MPTV

2001 That magical date seemed impossibly far away in 1968, when Arthur C. Clarke and director Stanley Kubrick released their classic film. Perhaps, we thought then, a manned trip to Jupiter in that distant time wasn't too far-fetched. After all, we were about to go to the moon. Today we know better. As our cover story tells, with an introduction by Clarke himself, the obstacles to a safe journey even to Mars and back are truly daunting. We are fragile spacefarers at best, and the odds of our species colonizing other worlds anytime soon are rather slim.

All the more reason, then, to protect and nurture our own small planet. To further that end, we this month launch a new department, EarthPulse, that will report on relevant conservation issues. It is one piece of a larger Society-wide initiative to help raise environmental awareness.

Some aspects of *2001: A Space Odyssey* do ring true today. For instance, I am regularly tempted to disconnect my rebellious computer, as actor Keir Dullea (above) did to the murderous HAL 9000. More important, the unfolding wonders of the cosmos still thrill me. So open the pod-bay door. I mean, turn the page. And by the way: Welcome to the new millennium—again.

Bill Allen

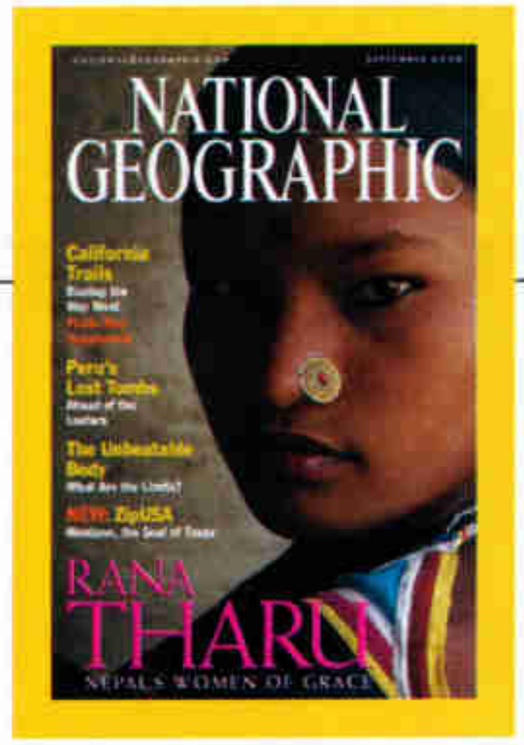
THE 2001 4RUNNER

With Vehicle Skid Control (VSC) and available traction-enhancing systems like Active TRAC and Multi-Mode 4-wheel drive, the restyled Toyota 4Runner can take you almost anywhere. Which may require extra equipment.

www.toyota.com • 1-800-GO-TOYOTA

TOYOTA SUVs
THERE AND BACK.

Forum



September 2000

When our redesigned September issue landed in mailboxes, it left some of our readers nostalgic and others delighted to see the change. "It is with some sadness that I bid farewell to your magazine's old cover," wrote one reader, "but your new look—cover and all—has not changed the excellence inside." Another responded, "It looks great and feels alive."

ZipUSA

I spent some time in Mentone in the early 1950s, watching some oil wells being drilled. There were two cafés then and a few more people than now. Each of the cafés was the unofficial headquarters of one of the political factions. I ate in each of them and found it expedient to keep my mouth shut on things political. I was told that during one election they had to call in the Texas Rangers to count the votes.

STANLEY REYNOLDS
Midland, Texas

The "no lawyers" crack in your article about Mentone, Texas, was uncalled for. So there are no lawyers in town—I guess that means that there is no one for the church board to call for some free legal advice on that boundary dispute, no one for the working-class family to call in the middle of the night when their teenage son gets into some trouble (more free advice), no neighbor to approach over the backyard fence to ask about incorporating a small business. I am starting to think that maybe I should move to Mentone. They need me.

DUNCAN TURNER
Attorney-at-Law
Seattle, Washington

The citizens of Mentone no longer need to travel 75 miles to get to the nearest movie theater. They now have to go only 23 miles to Pecos, where the State Theatre has reopened. The restored theater has several neat touches. One is a "crying room"—a glass-fronted room with speakers in it so parents of babies can see the movie and the other patrons are able to hear it.

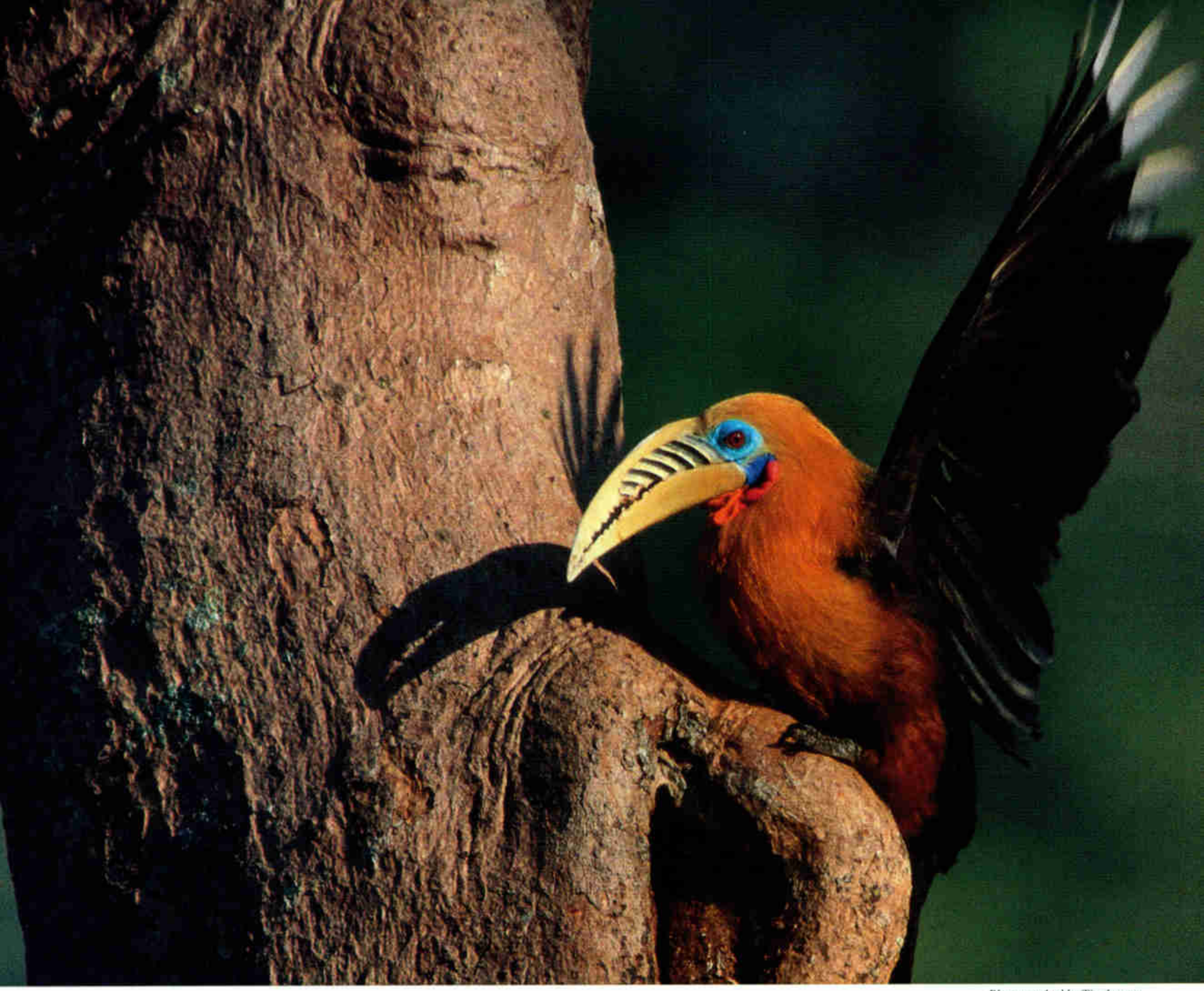
CINDY SHORES
Pecos, Texas

Congratulations on the inauguration of your new feature. If you decide to highlight zip code 71749, however, you will have to decide whether to cover Junction City in Union County, Arkansas, Junction City in Union Parish, Louisiana, or Junction City in Claiborne Parish, Louisiana. This anomaly is due to the fact that zip codes represent locations of delivering post offices, and, in this case, one office delivers across counties and across states.

AARON SUBAR
Monsey, New York

Rana Tharu Women

As a Peace Corps volunteer in Nepal I met Eric Valli on a dusty road outside my village and learned he was working on an



Photographed by Tim Laman

WILDLIFE AS CANON SEES IT

Bathed in late afternoon sunlight, a rufous-necked hornbill lands on its nest tree. Sealed inside the nest cavity, 20 meters above the ground, the female waits each day for her mate to bring food. For over three months she remains confined and dependent, emerging only after their chick fledges. Mated for life, the pair fly together high above the forest foraging for fruit, their high-pitched wingbeats and repeated cries to one another resounding across the valleys. Where the male displays luminous rufous feathers, the female is all black. Populations of the rufous-necked hornbill continue to decline, a result of habitat loss and hunting.

As a global corporation committed to social and environmental concerns, we join in worldwide efforts to promote greater awareness of endangered species for the benefit of future generations.

Rufous-necked Hornbill *(Aceros nipalensis)*
Size: Length, 90-100 cm
Weight: Male, 2.5 kg; female, 2.3 kg
Habitat: Dense evergreen and deciduous forest at 700-2,000 m from northeast India to Vietnam
Surviving number: Fewer than 1,000 in Thailand, its last stronghold; no estimates elsewhere

The Unbeatable Body

I was moved to write by the profile and poignant photo on pages 32-3 [right]. All I want to say to the elite athlete Jason Wening is "thank you." Neither poetry nor art nor philosophy can express more eloquently the nobility of your words and example. You epitomize the heights of human potential.

CHRISTOPHER S. SOHNLY
Chester, Pennsylvania

While I enjoyed Rick Gore's article, I was puzzled by the insistence that the largest contributing factor in producing a great athlete is genes. If genes are the critical factor, the intense training time and enormous drive that top athletes have would not be necessary. Genes are only the potential. The environment and the will produce the result. I was always fascinated by the fact that the great baseball slugger Jose Canseco has an identical twin who never made it in the big leagues. While given the exact same set of genes, the brother is nowhere near the player Jose is. The only explanation: One had to have wanted it more.

THEODORA T. TILTON
Alexandria, Virginia

Thanks for an unbiased portrayal of a shooting sport, biathlon (pages 22-3). It helps show what upstanding firearms-owning Americans have long recognized: The mind-and-body control needed for accurate target shooting is truly Olympian.

JIM RITICHER
Atlanta, Georgia

JOE MCNALLY

Though I never served in the military, I admire the effort any person puts forth to become a Navy SEAL. The question on page 18, "Who are the strong and who are the weak?" is inappropriate and unfair. These young men go through extensive screening before they are ever given the opportunity to compete to be SEALs. They're all strong in my book.

TIM SCHAAFSMA
Venlo, Netherlands

article about the Tharus. The article did not disappoint in its accurate and touching portrayal. Thank you very much, Eric and Debra Kellner.

CHRISTA PURNELL
Atlanta, Georgia

The Clouded Leopard

As a handler, educator, and trainer at the San Diego Zoo, I have worked with five clouded leopards over the past 15 years. The response by the public upon viewing the cloudeds always remains the same: There is awe at their beauty. They are truly gentle spirits of the jungle and create a passion in all who are fortunate to work with them.

HEIDI ENSLEY
San Diego, California

The article by 17-year-old Jesse Oak Taylor-Ide is remarkable. Regarding rat meat: Muskrat is still considered a delicacy in parts of Kentucky and Ohio. The meat is dark and tends to be oily but is better than the barn rat that sometimes was a staple during World War II.

HENRY R. KREIDER
St. Petersburg, Florida

Geographica

I read with interest your update on the source of emeralds, but I disagree with your conclusion that "none of the nine gems was from India." You state that one of the emeralds came from Pakistan. The country of Pakistan was created in 1947 and prior to that the area was, in fact, considered India. Therefore, there appears to be some truth to the legend that India, as it existed in the 16th and 17th centuries, was a source of at least one of the emeralds in your article.

CHRISTOPHER R. CHITAMBAR
Milwaukee, Wisconsin

Permian Extinction

Another thought-provoking article, but the artistic license? Spotted and striped *Lystrosaurus*, *Pareiasaurus*, and *Diictodon?* I was under the impression that the latest technology can establish shape and form, perhaps even texture, from the skeletons but not skin color or markings. Can these now be verified?

AUDREY BRADFORD
Valencia, Spain

Rarely. Artists use living creatures as models, borrowing the bold, contrasting markings that serve many as camouflage.

WRITE TO FORUM

National Geographic Magazine, PO Box 98198, Washington, DC 20090-8198, or by **fax** to **202-828-5460,** or via the **Internet** to **ngsforum@nationalgeographic.com.** Include name, address, and daytime telephone. Letters may be edited for clarity and space.

Bored With Earth Yet?

We'll take you on an automated tour of the galaxy

...for only $299.

MEADE® ETX-60AT Astro Telescope

Let Meade ultra-high-resolution optics take you on an automatic guided tour of the heavens. The rings of Saturn, the Orion Nebula, the Andromeda Galaxy, or any of 1400 other celestial wonders stored in the Autostar hand controller's database. Select an object, press GO TO, and watch as the ETX-60AT moves to the object, places it in the field of view, and tracks it across the sky — *automatically, first time, every time!*

ETX-60AT Astro Telescope, complete as shown, with Autostar Hand Controller — $299

Call **1-800-62-MEADE** for a free copy of Meade Telescope Catalog #120 or for a dealer location near you. Meade telescopes and accessories are available at over 3000 Meade dealer locations in the U.S.A. and Canada. Price listed is typical street-retail price.

WOLF CAMERA 1-888-644-WOLF wolfcamera.com

NATIONAL GEOGRAPHIC SOCIETY 1-888-225-5647 nationalgeographic.com

STORE OF KNOWLEDGE 1-800-241-5858 storeofknowledge.com

Discovery CHANNEL STORE 1-877-DCISTORE discovery.com

RITZ CAMERA & 1 HOUR BIG PRINT 1-800-52-FOCUS ritzcamera.com

amazon.com.

MEADE INSTRUMENTS CORPORATION 6001 Oak Canyon, Irvine, CA 92618. (949) 451-1450. FAX: (949) 451-1460. www.meade.com

The largest-selling telescopes in the world • A NASDAQ Company

Your photograph showing all the creatures that lived during and after the Permian period (page 106) is wrong. Most of the more impressive trilobites are from the Silurian period and were already extinct by the beginning of the Permian period.

SIMON COHEN
Bristol, England

Yes, most trilobites were already gone when the Permian extinction killed the rest. The pre-extinction fossils in the photograph represent the entire Paleozoic era, including the Silurian.

The Way West

Your article is greatly appreciated by those of us known as "rut nuts." The author points to the "scant surviving ruts," which is unfortunately true. It is important that these traces be preserved as part of the story of the settlement of the West, including the story of the native peoples. In very few places can one observe the landscape as it was seen by the early residents and emigrants.

DAVID J. WELCH
President, Oregon-California Trails Association
Independence, Missouri

The triumphal account of the California migration has a serious omission. The article states accurately that there were only about 14,000 Anglos and Hispanics living in California Alta in 1848, but it does not mention that there were approximately 150,000 Native Americans living in this territory.

DOYAL W. PINKARD
Austin, Texas

Population figures were given only for Anglos and Hispanics because the context was California's petition for statehood, for which Native Americans were not counted.

John Mitchell's article brought to mind my great-grandfather Thomas J. Cropper. He sailed to California from Baltimore, Maryland, on the *Jane Henderson* on March 15, 1850. On August 13, 1850, his first day in San Francisco, he wrote: "I was never more disgusted at anyplace in my life. I began to regret being [sic]." Like countless others he grew tired of the outrageous prices, the rampant gambling, and falling asleep dreaming of his "native home." He lasted three years before returning to Baltimore. And it's a good thing he did. If he hadn't, he never would have met and married my great-grandmother Mary E. Campbell, and someone else would be writing this letter.

It is important that these traces be preserved as part of the story of the settlement of the West. In very few places can one observe the landscape as it was seen by the early residents and emigrants.

PHILLIP F. LIESKE
Millers, Maryland

Migration Map

The Great Basin of Nevada and Utah is not the only area of the U.S. that does not drain to either ocean. The Great Divide Basin of Wyoming, north and west of Rawlins and extending to the famous South Pass, has no outlet either. I once lived in Rawlins, and the basin, or Red Desert as it is called locally, is a great place to hunt rocks. It was once the bottom of an inland sea.

MIKE PIERCE
South Colby, Washington

I was quite impressed with the map on the western migration until I read the caption on the Mormon migrations. The statement that Native Americans were believed to be the lost tribes of Israel is inaccurate. Early Mormon pioneers viewed Native Americans as descendants of the House of Israel and accorded them more respect than their non-Mormon counterparts cared to show.

NIKI COULTER
Professor of History
Rogue River, Oregon

Your Pathfinders map misplaces Mission San Gabriel Arcángel. I work in the San Gabriel Unified School District and have never worked near the beach nor west of Los Angeles. While that would be nice, I enjoy the city where it is, northeast of Los Angeles.

BRIAN HACKER
Glendora, California

I'm an American whose family, descendants of Spanish colonialists in New Mexico, has lived here for nearly 400 years. We owned quite a bit of land until the U.S. government seized much of it under the draconian terms of the Treaty of Guadalupe Hidalgo, signed in 1848 after the Mexican War. A casual reader might get the impression that "Americans" are only those people who came from back East and that no "Americans" lived here prior.

ANTONIO LÓPEZ
Santa Fe, New Mexico

DID THE SEA CALL HER BY NAME?

As a child, the sea fascinated her. Every wave, shell and creature held her spellbound. Years later, this incredible bond has grown. Her name is Sylvia Earle. She's pioneered research on marine ecosystems. Led more than 50 expeditions. Logged over 6,000 hours underwater. And holds numerous diving records. She even played a key role in the U.S. government's decision to double the budget of the National Marine Sanctuaries. Dr. Sylvia Earle, marine biologist, and National Geographic explorer-in-residence, is one of Ford Motor Company's Heroes for the Planet. A program that's part of ongoing Ford Motor Company initiatives to underwrite and support efforts that make the world a better place. To learn more about Dr. Earle and other Heroes for the Planet, visit our website. You'll find fascinating information, including links to her favorite sites. Around the globe, there are amazing individuals who've dedicated their lives to our planet. So, stop by. The world is waiting.

HEROES FOR THE PLANET
www.ford.com/heroes
Ford Motor Company

EarthPulse

FISHERIES

Conserving the Sea

Though many fisheries are depleted, some key stocks are recovering

How much can we take from the sea? How much can the sea take? Bigger boats, with bigger nets and better electronics, plow the ocean for fish. The global harvest soared from 17 million metric tons in 1950 to 78 million tons in the mid-1980s and has leveled off at that figure. In addition, an enormous amount is wasted as bycatch—unwanted species that are caught along with the target. Each year an estimated 20 to 40 million tons of mostly dead fish are thrown back.

During the 1990s many species were severely overfished in U.S. waters. Aided by tougher regulations, 17 of these fish stocks, such as yellowtail flounder, are rebounding. But nine others, including black sea bass, are now declining.

Worldwide, some nations' fishing fleets plunder the seas at will, while other countries strive to conserve marine resources. When valuable species cross from one nation's waters to another's, fish wars can result, such as the long feud between Canada and the U.S. over Pacific salmon. Attempts at quotas and regulations have had mixed results. Building blocks for international jurisdiction may lie in a United Nations treaty now nearing ratification. It would set unified standards for fisheries conservation and management.

Sailfish

About 68 tons were unintentionally hooked in 1996 on Atlantic longlines set for tuna and other species. The bycatch also included 227 tons of marlin, another billfish.

Bluefin tuna

The sea's most expensive fish can reach 1,500 pounds. Most are sold to Japan, currently for five to ten dollars a pound. The recent eastern Atlantic catch of 45,000 tons a year exceeds an international quota.

Spanish mackerel

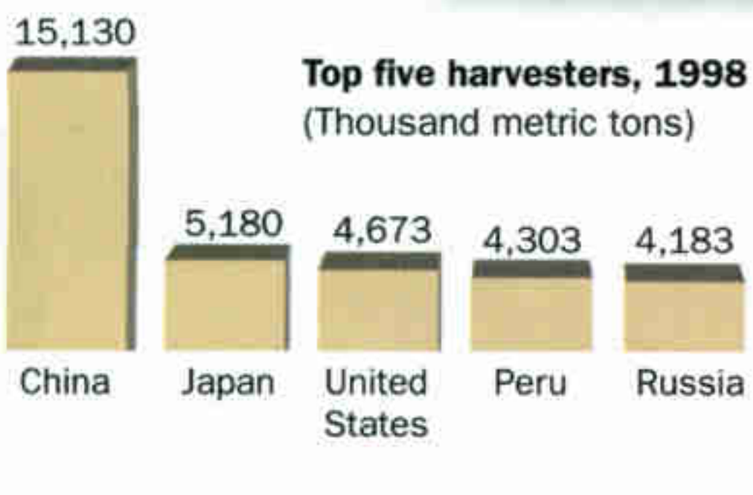
Harvested commercially since the 1850s, these mackerel range western Atlantic waters and the Gulf of Mexico. By the mid-1980s they were seriously overfished in the Gulf. Strict quotas have helped their recovery. About 3,500 tons are now caught annually—a sustainable yield.

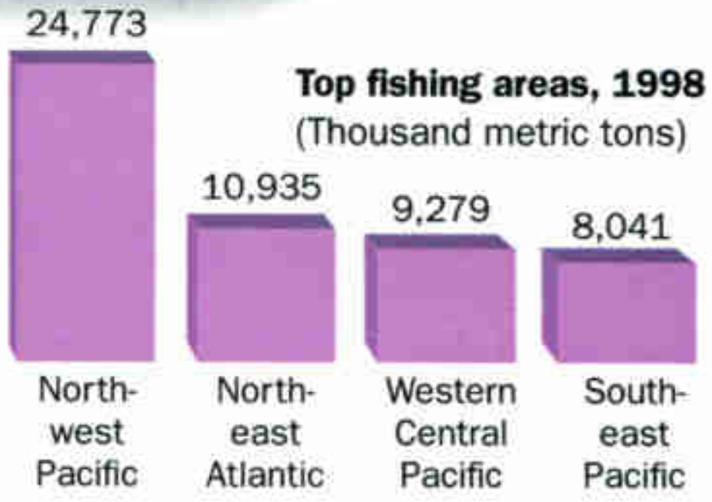
Red snapper

Millions of juvenile snappers die as bycatch in Gulf shrimpers' nets each year, so the species is depleted. Commercial and recreational fishermen catch about 3,500 tons annually. Fishery managers hope to rebuild stocks by 2019.

Orange roughy

Fishermen in Australia and New Zealand began harvesting this species only in the mid-1980s. The catch soon reached 4,600 tons a year—enough, it was feared, to deplete stocks. Now strict regulations are in place. Roughy swim in dense schools and take 20 years to mature.





Troubled Waters

1 Heavily fished Alaska pollock, often sold as imitation crabmeat, is also favored by endangered Steller sea lions. Regulations seek to reduce competition in U.S. waters.

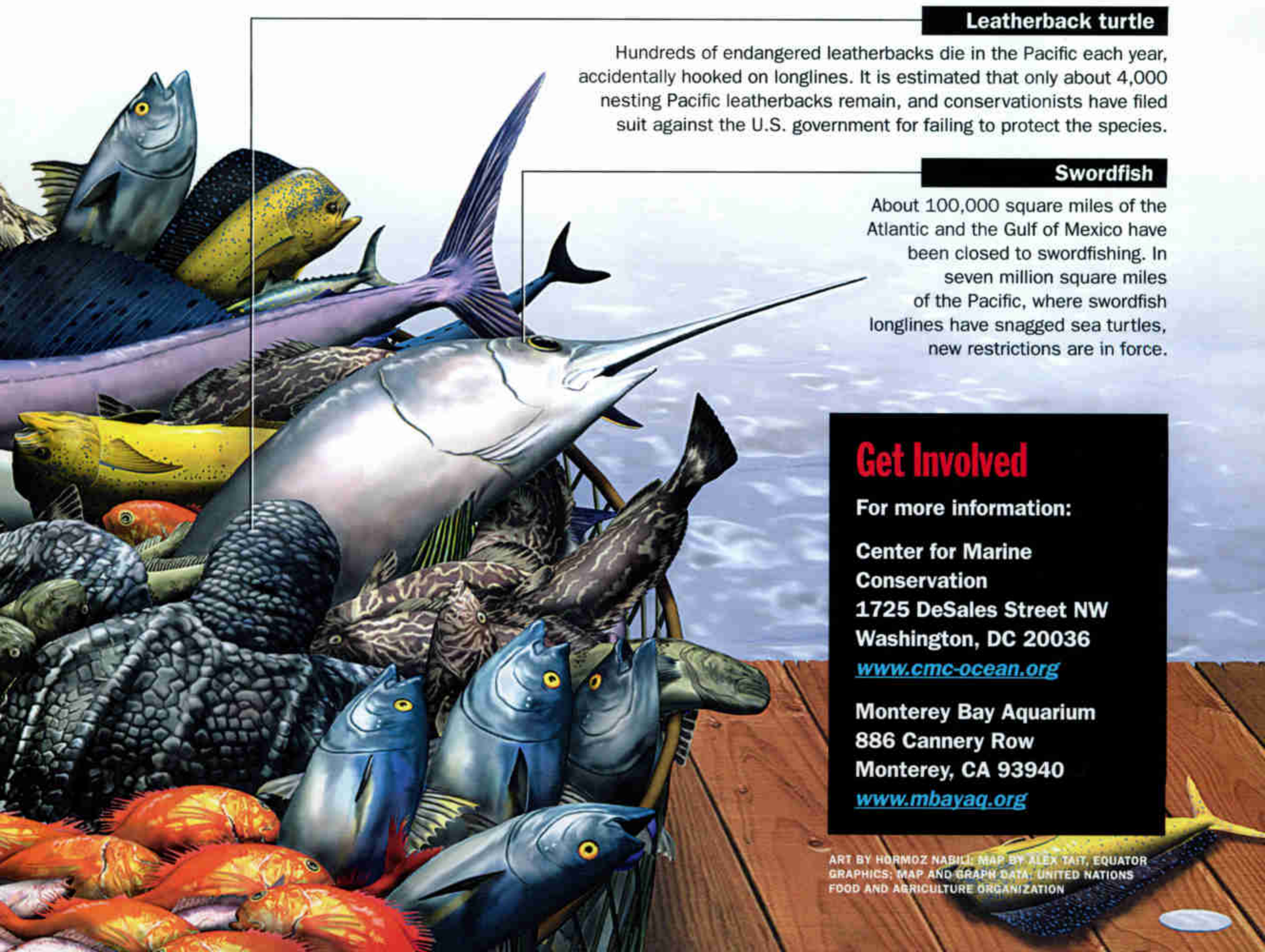
2 Seabirds, including the rare and endangered short-tailed albatross, become entangled and die on longline hooks of the North Pacific fishery.

3 Dynamite and cyanide fishing damage reefs. Climate change may spur high temperatures that bleach the Great Barrier Reef (pages 30-57).

4 Sold as Chilean sea bass, Patagonian toothfish draw fleets to the Antarctic. Illegal landings exceed the 14,500-ton limit by at least 7,000 tons.

5 The bite of longline hooks threatens even great white sharks. They are protected off Australia, the Maldives, southern Africa, and parts of the U.S.

6 Off New England, tough restrictions on Georges Bank are bringing back haddock and yellowtail flounder fisheries.



Leatherback turtle

Hundreds of endangered leatherbacks die in the Pacific each year, accidentally hooked on longlines. It is estimated that only about 4,000 nesting Pacific leatherbacks remain, and conservationists have filed suit against the U.S. government for failing to protect the species.

Swordfish

About 100,000 square miles of the Atlantic and the Gulf of Mexico have been closed to swordfishing. In seven million square miles of the Pacific, where swordfish longlines have snagged sea turtles, new restrictions are in force.

Get Involved

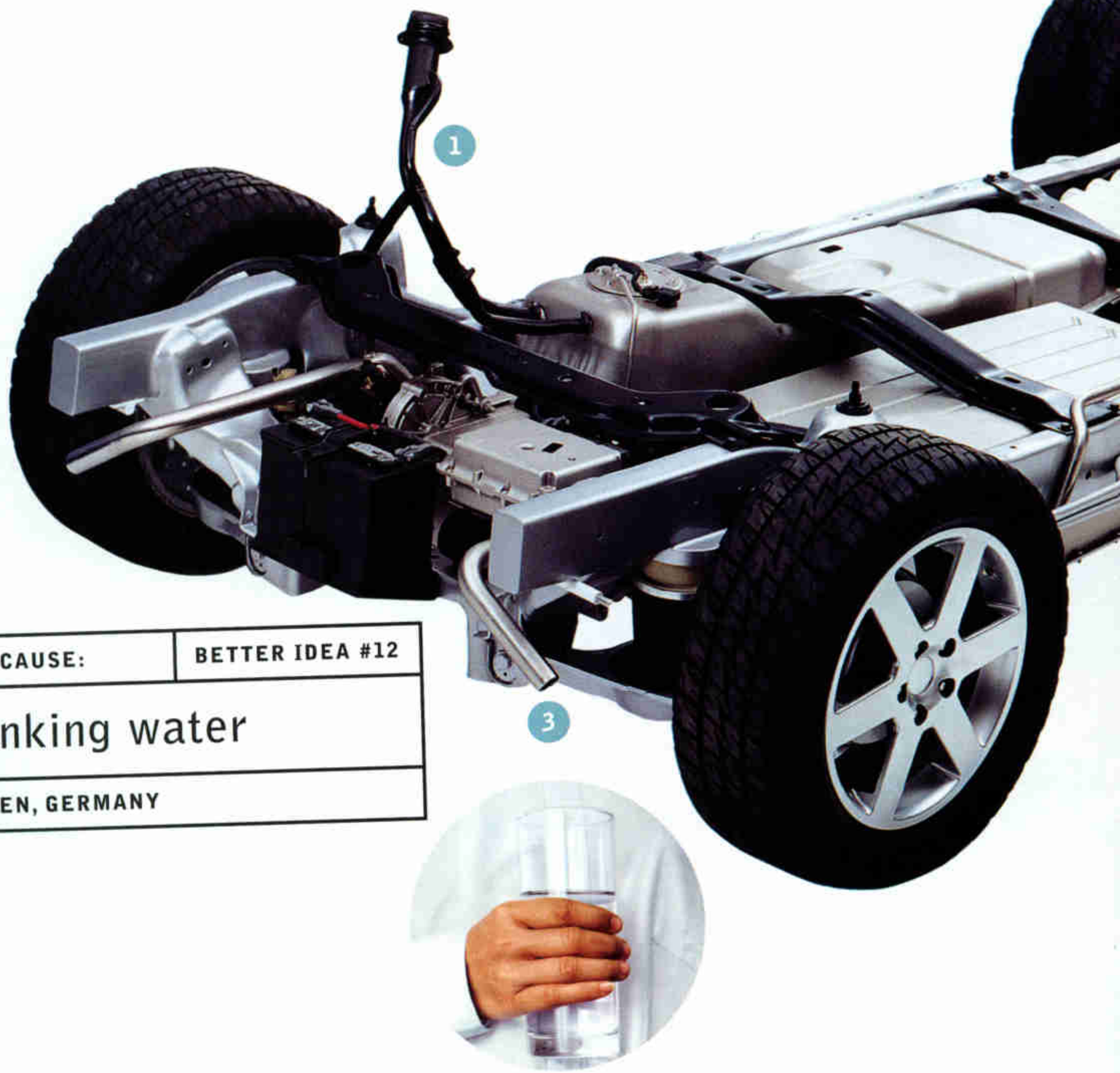
For more information:

Center for Marine Conservation
1725 DeSales Street NW
Washington, DC 20036
www.cmc-ocean.org

Monterey Bay Aquarium
886 Cannery Row
Monterey, CA 93940
www.mbayaq.org

ART BY HORMOZ NABILI; MAP BY ALEX TAIT, EQUATOR GRAPHICS; MAP AND GRAPH DATA: UNITED NATIONS FOOD AND AGRICULTURE ORGANIZATION

Imagine being the has to explain this dinner table.



WWW.FORD.COM

WILL CAUSE:	BETTER IDEA #12
Drinking water	
AACHEN, GERMANY	

dad who one at the

1 Hydrogen
(and if there's anything this planet has, it's hydrogen) goes here.

2 Hydrogen connects with oxygen here.

They get to know one another.
Sparks fly.
Motor turns.
Wheels turn.
You get to the grocery store.

3 Water, that's right, water, comes out here.

Frankly, the fuel cell is a headscratcher. By combining hydrogen fuel with oxygen from the air it can produce energy silently, and without combustion. Using hydrogen, it generates electricity; the by-product is water. No emissions. No smog. Just water. Designing it is one thing. Getting people to believe it is another. We expect to deliver our first fuel cell-powered passenger cars for testing in California this year.

Mark Sulek, Dreamer/Doer,
can explain the beauty of Ford's fuel cell technology to people who still have trouble understanding how a thermos works.

Ford Motor Company

CONSERVATION

Caring Hands in Kenya

For decades a nursery has given orphaned animals a chance

Tuckered out and tucked in, five-month-old Yatta will be guarded from things that go bump in the night by her surrogate family—Charles Mutuku and fellow keepers in Kenya. The young elephant was traumatized when poachers killed her mother.

Yatta and other orphans, including rhino calves, sleep in stables at the David Sheldrick Wildlife Trust nursery, run by veterinarian Daphne Sheldrick. Early efforts to nurse baby elephants failed. It took time to grasp their emotional needs—and to develop a formula they could digest. "I struggled for 28 years to get it right," says Sheldrick, who finally succeeded with a coconut-fat mix in 1987.

The elephant calves' reintroduction to the wild is gradual. From the nursery they are first moved to Tsavo National Park. After being weaned at about age two, they are relocated to Tsavo East National Park and join an orphan herd led by a matriarch called Emily. She keeps a watchful eye on them as they roam the park all day, gradually getting to know the local elephants.

Daphne's late husband, David, served as Tsavo East's first warden from 1948 until his death in 1976.

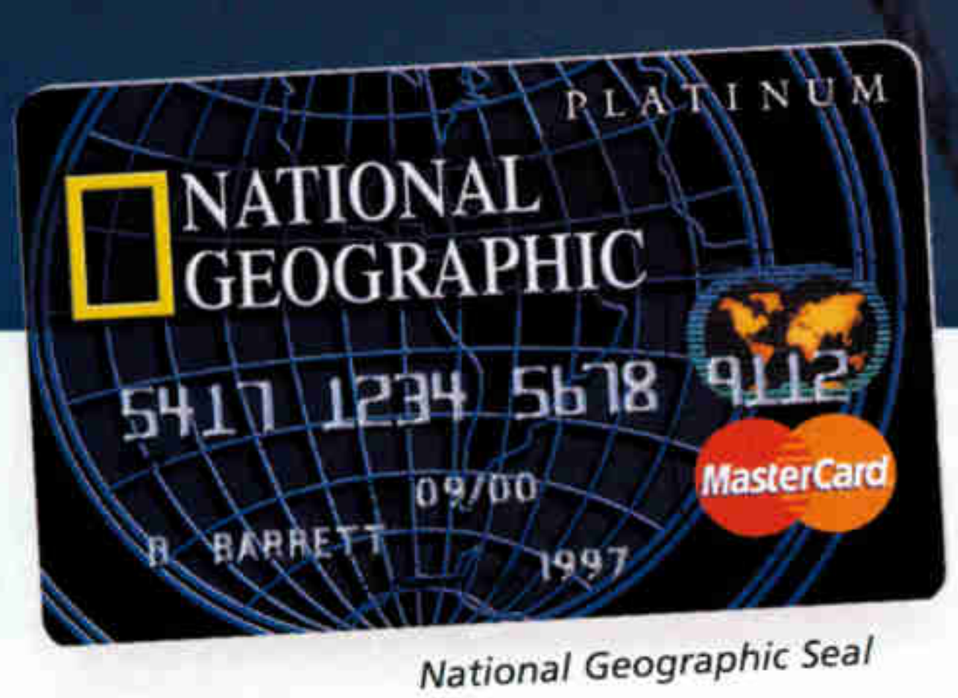
APHICA

CREATURES OF OUR UNIVERSE

DAVID HIGGS, ENVIRONMENTAL PRESS AGENCY

FREE CARD REPLACEMENT IF LOST, STOLEN OR DEVOURED.

2.9%
Introductory APR with a balance transfer[1]



National Geographic Seal

emergency cash & card replacement • lost luggage insurance
no annual fee • credit line from $5,000 to $100,000[2]
travel accident insurance[3] • purchases support the Society's vital programs such as environmental efforts, exploration, scientific research, and geography education.

[1]Offer subject to credit approval. If you transfer a balance with your application, the introductory 2.9% fixed APR on purchases and balance transfers will remain in effect for the first nine (9) billing cycles following the opening of your account. After that, a 12.99% fixed APR on purchases and balance transfers. If you do not transfer a balance with your application, the introductory APR is not offered and the APR for all purchases and balance transfers will be 12.99% fixed. If payment is received late once during the introductory period, the APR on purchases and balance transfers will adjust to 19.99% fixed. If, at any time, payment is received late twice during any 6-month period, the APR on balances will adjust to 19.99% fixed. The annual fee: NONE. A minimum monthly Finance Charge is due. There is a Finance Charge for cash advances equal to 2% of the advance with a $10 minimum. There is a Transaction Finance Charge for the purchase of foreign currency and travelers checks from other than a bank and the use of convenience checks equal to 2% of the transaction amount with a $5 minimum, maximum of $50. There is a Transaction Fee for use of balance transfers, 3% of the amount of each balance transfer, but not less than $5.00, maximum of $50. The lender on your account will be First USA Bank, P.O. Box 8658, Wilmington, Delaware 19899-8658. You should contact the Bank Service Center to obtain information of any changes occurring after the printing date below by calling toll-free 1-800-537-6954. This offer is available only to applicants who reside in the United States. Print date 11/00 [2]In certain instances, you may receive a Standard card with a credit line up to $5,000. [3]Available to First USA Platinum MasterCard cardmembers only.

Photo by: David Doubilet

What's life without adventure?
What's adventure without
a little peace of mind?

With a very low APR, no annual fee
and a host of valuable benefits,
the National Geographic Platinum
MasterCard® is essential survival gear.

Equally valuable, your purchases
support the Society's mission, including
vital programs such as environmental
efforts, exploration, scientific research,
and geography education.

Choose from 8 compelling designs,
and gear up.

©National Geographic Society
www.nationalgeographic.com

Arctic After Hours

Grand Canyon Sunset

Capturing the Moment

Exotic Nature

History on Parade

Pyramids of Gizâi

Lionesses of Chobe

Look for a brand new cable television channel from National Geographic, coming this winter.

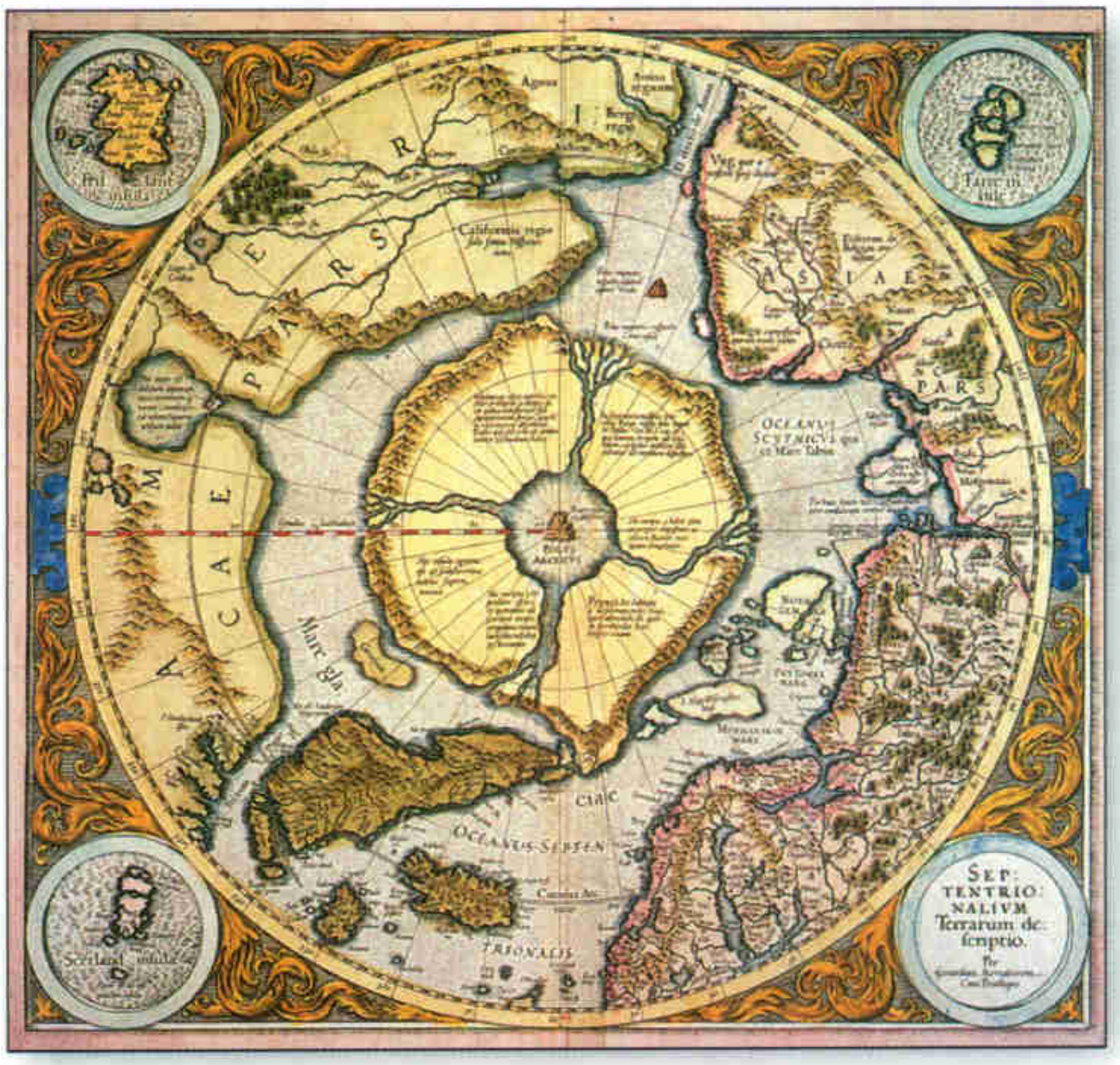
To apply, call toll free: 1·866·255·2353

Or apply online at www.ngstore.com

HISTORY

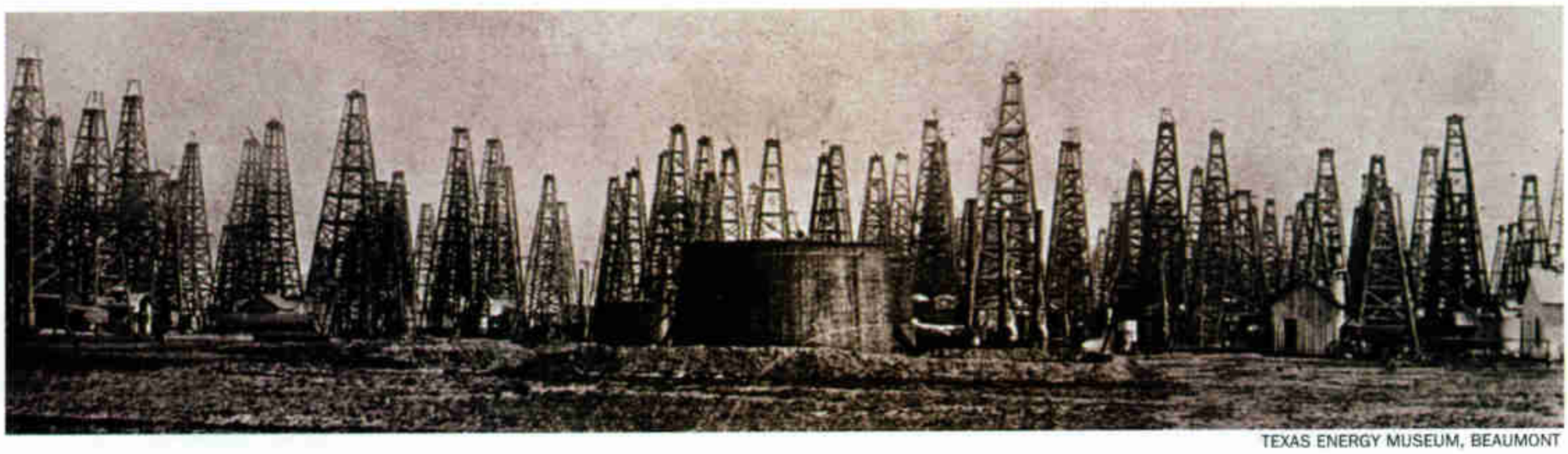
Northern Exposure

An exhibit traces the history of polar exploration



NEWBERRY LIBRARY

Flemish cartographer Gerardus Mercator's map of the Arctic (published in 1595) is on display in Chicago at the Newberry Library, whose polar exhibit runs until January 13. The engraved, hand-colored map shows four islands surrounding a point labeled "high, black rock"—the North Pole. Mercator based his map in part on the writings of an English monk who purportedly traveled throughout the north in 1360. Another source was English navigator John Davis, who probed the Arctic in the 1580s believing that a sea route from the Atlantic to the Pacific, the Northwest Passage, was "most probable, the execution easie." Instead, it remained elusive for 300 years.



TEXAS ENERGY MUSEUM, BEAUMONT

AMERICAN HISTORY

Oil's Well Here

Gusher centennial celebrates Texas' first big oil strike

They knew it was in there somewhere. For years prospectors had hoped to find oil under Spindletop Hill in Beaumont, Texas. On January 10, 1901, after two and a half months of dedicated drilling, they finally hit black gold.

Spindletop was the first Texas gusher—and the world's largest at the time—spewing 100,000 barrels a day for nine days before it was capped. Within a year the hill was forested with wells (above), and some 600 oil companies had started up, including Texaco and Gulf. Beaumont's population swelled from 9,000 to 50,000 in six months. The Texas oil boom had begun.

Beaumont plans to celebrate Spindletop's centennial by re-creating the gusher. "But we'll use water instead of oil," says a local official. "Easier to clean up."

ALMANAC

January

In the far north, snowshoe hares have passed the peak of their ten-year population cycle and now are crashing. As the hares' numbers rose, so did those of their predators—chiefly the lynx but also coyotes, owls, and foxes. Now the hunters will dwindle along with the hunted.

ART BY MATTHEW FREY

I'm proud of him because he asked about VIAGRA.

—VIAGRA has shown improvement in erectile function in 4 out of 5 men compared with 1 out of 4 for sugar tablets

—More than 6 million men in the US have been prescribed VIAGRA (1 million were also taking blood pressure–lowering medication)

I love him because he did it for us.

VIAGRA is effective and well tolerated in a variety of patients. More than 17 million prescriptions have been written in the United States.*

VIAGRA is not for everyone. Be sure to ask your doctor if your heart is healthy enough to handle the extra strain of sexual activity. If you have chest pains, dizziness, or nausea during sex, stop and immediately tell your doctor. If you're a man who uses nitrate drugs, never take VIAGRA—your blood pressure could suddenly drop to an unsafe level. With VIAGRA, the most common side effects are headache, facial flushing, and upset stomach. VIAGRA may also briefly cause bluish vision, sensitivity to light, or blurred vision. In the rare event of an erection lasting more than 4 hours, seek immediate medical help. Remember to protect yourself and your partner from sexually transmitted diseases.

Please see patient summary of information about VIAGRA (25-*mg*, 50-*mg*, 100-*mg*) *tablets on the following page.*

*Data on file. Pfizer Inc., New York, NY.

Ask your doctor if a FREE TRIAL of VIAGRA is right for you.
For more information, call 1-888-4VIAGRA or visit www.viagra.com.

VIAGRA®
(sildenafil citrate) tablets
Love life again.

Love life again.

PATIENT SUMMARY OF INFORMATION ABOUT

VIAGRA®
(sildenafil citrate) tablets

This summary contains important information about VIAGRA®. It is not meant to take the place of your doctor's instructions. Read this information carefully before you start taking VIAGRA. Ask your doctor or pharmacist if you do not understand any of this information or if you want to know more about VIAGRA.

This medicine can help many men when it is used as prescribed by their doctors. However, VIAGRA is not for everyone. It is intended for use only by men who have a condition called erectile dysfunction. **VIAGRA must never be used by men who are taking medicines that contain nitrates of any kind, at any time. This includes nitroglycerin. If you take VIAGRA with any nitrate medicine your blood pressure could suddenly drop to an unsafe or life threatening level.**

What Is VIAGRA?

VIAGRA is a pill used to treat erectile dysfunction (impotence) in men. It can help many men who have erectile dysfunction get and keep an erection when they become sexually excited (stimulated).

You will not get an erection just by taking this medicine. VIAGRA helps a man with erectile dysfunction get an erection only when he is sexually excited.

How Sex Affects the Body

When a man is sexually excited, the penis rapidly fills with more blood than usual. The penis then expands and hardens. This is called an erection. After the man is done having sex, this extra blood flows out of the penis back into the body. The erection goes away. If an erection lasts for a long time (more than 6 hours), it can permanently damage your penis. You should call a doctor immediately if you ever have a prolonged erection that lasts more than 4 hours.

Some conditions and medicines interfere with this natural erection process. The penis cannot fill with enough blood. The man cannot have an erection. This is called erectile dysfunction if it becomes a frequent problem.

During sex, your heart works harder. Therefore sexual activity may not be advisable for people who have heart problems. Before you start any treatment for erectile dysfunction, ask your doctor if your heart is healthy enough to handle the extra strain of having sex. If you have chest pains, dizziness or nausea during sex, stop having sex and immediately tell your doctor you have had this problem.

How VIAGRA Works

VIAGRA enables many men with erectile dysfunction to respond to sexual stimulation. When a man is sexually excited, VIAGRA helps the penis fill with enough blood to cause an erection. After sex is over, the erection goes away.

VIAGRA Is Not for Everyone

As noted above (*How Sex Affects the Body*), ask your doctor if your heart is healthy enough for sexual activity.

If you take any medicines that contain nitrates–either regularly or as needed–you should never take VIAGRA. If you take VIAGRA with any nitrate medicine or recreational drug containing nitrates, your blood pressure could suddenly drop to an unsafe level. You could get dizzy, faint, or even have a heart attack or stroke. Nitrates are found in many prescription medicines that are used to treat angina (chest pain due to heart disease) such as:

- nitroglycerin (sprays, ointments, skin patches or pastes, and tablets that are swallowed or dissolved in the mouth)
- isosorbide mononitrate and isosorbide dinitrate (tablets that are swallowed, chewed, or dissolved in the mouth)

Nitrates are also found in recreational drugs such as amyl nitrate or nitrite ("poppers"). If you are not sure if any of your medicines contain nitrates, or if you do not understand what nitrates are, ask your doctor or pharmacist.

VIAGRA is only for patients with erectile dysfunction. VIAGRA is not for newborns, children, or women. Do not let anyone else take your VIAGRA. VIAGRA must be used only under a doctor's supervision.

What VIAGRA Does Not Do

- VIAGRA does not cure erectile dysfunction. It is a treatment for erectile dysfunction.
- VIAGRA does not protect you or your partner from getting sexually transmitted diseases, including HIV–the virus that causes AIDS.
- VIAGRA is not a hormone or an aphrodisiac.

What To Tell Your Doctor Before You Begin VIAGRA

Only your doctor can decide if VIAGRA is right for you. VIAGRA can cause mild, temporary lowering of your blood pressure. You will need to have a thorough medical exam to diagnose your erectile dysfunction and to find out if you can safely take VIAGRA alone or with your other medicines. Your doctor should determine if your heart is healthy enough to handle the extra strain of having sex.

Be sure to tell your doctor if you:

- have ever had any heart problems (e.g., angina, chest pain, heart failure, irregular heart beats, or heart attack)
- have ever had a stroke
- have low or high blood pressure
- have a rare inherited eye disease called retinitis pigmentosa
- have ever had any kidney problems
- have ever had any liver problems
- have ever had any blood problems, including sickle cell anemia or leukemia
- are allergic to sildenafil or any of the other ingredients of VIAGRA tablets
- have a deformed penis, Peyronie's disease, or ever had an erection that lasted more than 4 hours
- have stomach ulcers or any types of bleeding problems
- are taking any other medicines

VIAGRA and Other Medicines

Some medicines can change the way VIAGRA works. Tell your doctor about **any medicines** you are taking. Do not start or stop taking any medicines before checking with your doctor or pharmacist. This includes prescription and nonprescription medicines or remedies. Remember, VIAGRA should never be used with medicines that contain nitrates (see *VIAGRA Is Not for Everyone*). If you are taking a protease inhibitor, your dose may be adjusted (please see *Finding the Right Dose for You.*) VIAGRA should not be used with any other medical treatments that cause erections. These treatments include pills, medicines that are injected or inserted into the penis, implants or vacuum pumps.

Finding the Right Dose for You

VIAGRA comes in different doses (25 mg, 50 mg and 100 mg). If you do not get the results you expect, talk with your doctor. You and your doctor can determine the dose that works best for you.

- Do not take more VIAGRA than your doctor prescribes.
- If you think you need a larger dose of VIAGRA, check with your doctor.
- VIAGRA should not be taken more than once a day.

If you are older than age 65, or have serious liver or kidney problems, your doctor may start you at the lowest dose (25 mg) of VIAGRA. If you are taking protease inhibitors, such as for the treatment of HIV, your doctor may recommend a 25 mg dose and may limit you to a maximum single dose of 25 mg of VIAGRA in a 48 hour period.

How To Take VIAGRA

Take VIAGRA about one hour before you plan to have sex. Beginning in about 30 minutes and for up to 4 hours, VIAGRA can help you get an erection if you are sexually excited. If you take VIAGRA after a high-fat meal (such as a cheeseburger and french fries), the medicine may take a little longer to start working. VIAGRA can help you get an erection when you are sexually excited. You will not get an erection just by taking the pill.

Possible Side Effects

Like all medicines, VIAGRA can cause some side effects. These effects are usually mild to moderate and usually don't last longer than a few hours. Some of these side effects are more likely to occur with higher doses. The most common side effects of VIAGRA are headache, flushing of the face, and upset stomach. Less common side effects that may occur are temporary changes in color vision (such as trouble telling the difference between blue and green objects or having a blue color tinge to them), eyes being more sensitive to light, or blurred vision.

In rare instances, men have reported an erection that lasts many hours. You should call a doctor immediately if you ever have an erection that lasts more than 4 hours. If not treated right away, permanent damage to your penis could occur (see *How Sex Affects the Body*).

Heart attack, stroke, irregular heart beats, and death have been reported rarely in men taking VIAGRA. Most, but not all, of these men had heart problems before taking this medicine. It is not possible to determine whether these events were directly related to VIAGRA.

VIAGRA may cause other side effects besides those listed on this sheet. If you want more information or develop any side effects or symptoms you are concerned about, call your doctor.

Accidental Overdose

In case of accidental overdose, call your doctor right away.

Storing VIAGRA

Keep VIAGRA out of the reach of children. Keep VIAGRA in its original container. Store at room temperature, 59°-86°F (15°-30°C).

For More Information on VIAGRA

VIAGRA is a prescription medicine used to treat erectile dysfunction. Only your doctor can decide if it is right for you. This sheet is only a summary. If you have any questions or want more information about VIAGRA, talk with your doctor or pharmacist, visit www.viagra.com, or call 1-888-4VIAGRA.

23-5515-00-4

VIAGRA®
(sildenafil citrate) tablets

Printed in USA/October 2000

Pfizer U.S. Pharmaceuticals

This is not a photo...

...it's a digital image.

It's not a photo until it's printed on Jet Print Photo® paper.

Jet Print Photo® offers a complete line of specially-formulated ink jet papers for all your digital photo needs, from photo proofs to professional quality, photo prints.

Jet PRINT Photo™

How Digital photos are finished.

Professional Photo Paper
Superior Gloss Finish

Premium Photo Paper
Brilliant Gloss Finish

Multi-Project Photo Paper
Gloss Finish

Photo Proofing Paper
Matte Finish

www.jetprintphoto.com

Behind the SCENES

AT THE NATIONAL GEOGRAPHIC SOCIETY

JIM FENHAGEN, PROFESSIONAL DESIGN GROUP

This Just In . . .

Daily news through a Geographic lens

When National Geographic Channel makes its debut in the U.S. this month, viewers will see a new kind of newscast from a set much like the designer's rendering above. And visitors to Washington, D.C., will have something new to see.

The programming centerpiece, a daily one-hour newscast called *National Geographic Today,* will feature "the news of the day as seen through the prism of National Geographic," says Andrew Wilk, the channel's executive vice president.

"Whether it's Bob Ballard returning from his newest underwater expedition, or Sylvia Earle reporting on her latest marine conservation project, or Paul Sereno on the next great dinosaur find, we'll be able to tap into our resources and bring our viewers a different kind of news."

The channel's newscast will be led by Mark Nelson, formerly of ABC News's *Nightline.* His staff will produce original coverage blending hard news and in-depth features with global field reports on natural disasters, newly unearthed cultural treasures, and the most recent scientific developments.

The broadcast will originate in the channel's "base camp" at Society headquarters, where news staff will have access to leading explorers, scientists, environmentalists, and filmmakers.

The 8,000-square-foot base-camp studio was designed by Jim Fenhagen, who also created sets for *Dateline NBC* and MSNBC.

To find out whether National Geographic Channel is available in your area, check with your local cable or satellite provider.

100 YEARS AGO

January 1901

"He finally reached Lhasa, where he had an interview with the Grand Lama . . . a fair and handsome boy of about thirteen years . . . attended by two of the highest priests, each holding a bundle of peacock feathers."
—"The Tsangpo," by James Mascarene Hubbard

Sticking it on a Honda LEV would be redundant.

When it comes to a clean environment, there's nothing wrong with repetition. Fortunately, we're not alone in this thinking. Over one million Hondas have been sold with low-emission technology, and more than 88% of our new vehicles are LEV-rated or cleaner.

This commitment to clean air took off in 1975. That's when our Civic CVCC became the first car without a catalytic converter to comply with the emission standards set by the 1970 U.S. Clean Air Act. However, we didn't stop there. In 1995, we voluntarily reduced smog-contributing hydrocarbons by 70% and became the first to meet California's strict Low-Emission Vehicle (LEV) standard. And for 2001, the all-new Civic is an Ultra-Low-Emission Vehicle (ULEV).

Today, the California Air Resources Board has recently issued an even stricter emissions standard for 2004: Super-Ultra-Low-Emission Vehicle (SULEV). Naturally, we've decided there's no reason to wait. The 2000 Accord SULEV* was the first gasoline-powered vehicle to meet this standard. And our dedication to the environment was recently recognized by the Union of Concerned Scientists, who named Honda Motor Co., the cleanest car company in the world.†

HONDA
Thinking.™

*Accord EX Sedan only available in California. †Based on a U.S. emissions study by the Union of Concerned Scientists. The Union of Concerned Scientists is an independent organization. Results do not imply endorsement of Honda or its products. honda.com

Imperial Memories

Emperor recalls useful reading

When Executive Editor Robert Poole and photographer Sam Abell met with Emperor Akihito and Empress Michiko at Japan's Imperial Palace (pages 120-123), the Emperor remembered reading NATIONAL GEOGRAPHIC as a boy.

"I used to look forward to seeing it in my father's library when I visited him after the war," said the Emperor. "I found the photographs fascinating. Then my tutor sent it to me. She thought it would help with my English." The Emperor is still speaking English—and still enjoying the magazine.

The Empress, too, knew the GEOGRAPHIC, describing an article she had read on the Celtic world, in which she has a special interest. And both were curious to see a copy of our Japanese-language edition (left). Noting a piece about morning glories, they recalled having enjoyed a recent exhibit of the flowers.

NATIONAL GEOGRAPHIC PHOTOGRAPHER SAM ABELL

A Gift of Maps

This month every school in the U.S. will receive ten free copies of a new map (right) produced by the Geographic and the World Wildlife Fund. The map, supported by Ford Motor Company, shows nearly a thousand "ecoregions" —areas with distinct climates, plant and animal communities, and other ecological features. The reverse side focuses on 200 of Earth's richest, rarest, and most at-risk areas. An interactive version is available at *nationalgeographic.com/wildworld.*

FOR MORE INFORMATION

Call: 1-800-NGS-LINE
(1-800-647-5463) Toll free from U.S., Canada, 8 a.m.–midnight ET, Mon.–Fri. 8:30 a.m.–7 p.m. ET, Sat.
For a free catalog call: 1-800-447-0647
Special device for the hearing-impaired (TDD) 1-800-548-9797
Write: National Geographic Society
PO Box 98199
Washington, DC 20090-8199
Internet: nationalgeographic.com

POLAR BEAR POSTER

A limited-edition print of Norbert Rosing's polar bears is available for $39.95 plus $6.50 for postage and handling ($9.50 for international orders). Please add appropriate sales tax for orders sent to CA, DC, FL, KY, MD, MI, PA, and Canada. We will produce only as many 24-by-30-inch posters as we receive orders for by February 1, 2001. Each print will be hand-numbered and embossed with the Society seal. Shipping is scheduled for April 2001.

Call toll free: 1-888-647-7301 (Outside the U.S. and Canada call 1-515-362-3353)
Mail orders to: National Geographic Society, PO Box 11303
Des Moines, IA 50340-1303

Mother Nature's Thighmaster

Mother Nature's Energy Bar

The crunchy 100% natural energy source made from whole grain oats.

The Energy Bar Nature Intended®

The Official Natural Energy Source of the US SKI TEAM

a system with everything i want for $849?

finally, santa got my wish list.

DELL™ DIMENSION™ L Series

Santa's Helper

- Intel® Pentium® III Processor at 800MHz
- 64MB SDRAM ■ 10GB[5] Ultra ATA Hard Drive
- 15" (13.8" vis) E551 Monitor ■ Intel® 3D® AGP Graphics
- 48X Max CD-ROM Drive
- SoundBlaster 64V PC LC Sound Card ■ PC Speakers
- V.90 56K Capable[6] PCI DataFax Modem for Windows®
- MS® Works Suite 2001 ■ MS® Windows® Me
- 3-Yr Limited Warranty[2] ■ 1-Yr At-Home Service[4]
- 1 Year of DellNet™ by MSN® Internet Access[10] Included

$849 E•VALUE CODE 89674-501208

ASK US ABOUT NO PAYMENTS FOR 90 DAYS.

Get a PC that has it all. From the people who have won more service and support awards than any other.

Get ready to bring it all home for the holidays. Not only does this Dell™ Dimension™ have a speedy Intel® Pentium® III processor and come complete for just $849, it's also backed by the best support in the industry. For five years running, Dell has won more awards for service and support than any other computer manufacturer. You'll also get one year of DellNet™ by MSN® Internet access[10] included with the purchase of a new Dell home system. All that, and you didn't even have to leave us any cookies. It's just one more way Dell4me™ helps you get the most out of your PC this holiday season.

intel inside pentium® III

DELL4me.com

contact us today | 888.862.3355 | www.dell4me.com | DELL.COM

Includes Windows Millennium Edition — the home version of the world's favorite software.

[10]**Telephone access (call your phone co. for details) and other surcharges for access may apply. Must register within 30 days of receiving computer and accept DellNet/MSN Terms of Service.** You agree to be billed monthly fees after the initial service period. You may cancel service at any time. Offer valid for new customers only in U.S. households and must be over 18 years old with major credit card. Limited time offer.

Prices, specifications, and availability may change without notice. Taxes and shipping charges extra, and vary. Cannot be combined with other offers or discounts. U.S. only. Offer valid for Dell Home Systems Co. only. [2]For a copy of our Guarantees or Limited Warranties, write Dell USA L.P., Attn: Warranties, One Dell Way, Round Rock, Texas 78682. [4]At-Home or on-site service provided via third-party contract with customer. Technician will be dispatched, if necessary, following phone-based troubleshooting. To receive Next-Business-Day service, Dell must notify the service provider before 5 pm (customer's time). Availability varies. Other conditions apply. [5]For hard drives, GB means 1 billion bytes; accessible capacity varies with operating environment. [6]Download speeds limited to 53Kbps. Upload speeds are less (about 30Kbps) and vary by modem manufacturer and online conditions. Analog phone line and compatible server required. Intel, the Intel Inside logo, and Pentium are registered trademarks of Intel Corporation. MS Microsoft, MSN, and Windows are registered trademarks of Microsoft Corporation.

From the President

DAVID ALAN HARVEY

NATIONAL GEOGRAPHIC CHANNEL

EARTHPULSE

Like the surging rhythms of a Cuban parade (above), excitement is rocking the halls of the National Geographic Society as we enter the new millennium.

The paint has just dried on a state-of-the-art television studio at our Washington, D.C., headquarters (see Behind the Scenes for a preview). This studio will serve as "base camp" for the National Geographic Channel, launching in the U.S. this month. Our cable programming (already distributed to more than 90 million subscribers internationally) will offer U.S. viewers unparalleled access to the world's wildlife, cultures, and adventures through the expertise of the Society's explorers, photographers, writers, and filmmakers. Our innovative nightly news program—*National Geographic Today*—will be a haven for people interested in how news of the day affects the planet.

We'll also inaugurate EarthPulse in partnership with Ford Motor Company, an initiative aimed at promoting better stewardship of the Earth. Each month our magazines, website, and television programming will spotlight issues of importance. We'll take the pulse of oceans, indigenous cultures, delicate ecosystems, and other areas facing challenges to a sustainable future.

These endeavors reflect an evolution in the Society's founding mission: to increase and diffuse geographic knowledge. Now we ask ourselves, *To what end?* Merely presenting information about the world is not enough. We feel it's important to help people understand the pressures threatening our natural, cultural, and historic treasures. The support of our members makes this expanded mission possible. When people care, they act. And when they act, they can make a difference.

P.S. Check with your cable or satellite provider for the availability of the National Geographic Channel in your area.

IMAGINE IF YOU COULD PLAN YOUR DAY AROUND YOUR LIFE INSTEAD OF YOUR ARTHRITIS PAIN.

MERCK

VIOXX IS HERE. 24-HOUR RELIEF FOR THE MOST COMMON TYPE OF ARTHRITIS PAIN, OSTEOARTHRITIS.

It isn't about winning a marathon. Or making you feel like a kid again. It's about controlling the pain that keeps you from doing everyday things. And VIOXX may help. VIOXX is a prescription medicine for osteoarthritis, the most common type of arthritis.

ONE PILL—ALL DAY AND ALL NIGHT RELIEF.

You take VIOXX only once a day. Just one little pill can relieve your pain all day and all night for a full 24 hours.

VIOXX EFFECTIVELY REDUCED PAIN AND STIFFNESS.

In clinical studies, once-daily VIOXX effectively reduced pain and stiffness. So VIOXX can help make it easier for you to do the things you want to do. Like sitting down on the grass to watch your kid's game.

TAKE WITH OR WITHOUT FOOD.

VIOXX doesn't need to be taken with food. So, you don't have to worry about scheduling VIOXX around meals.

IMPORTANT INFORMATION ABOUT VIOXX.

In rare cases, serious stomach problems, such as bleeding, can occur without warning. People with allergic reactions, such as asthma, to aspirin or other arthritis medicines should not take VIOXX.

Tell your doctor if you have liver or kidney problems, or are pregnant. Also, VIOXX should not be used by women in late pregnancy.

VIOXX has been extensively studied in large clinical trials. Commonly reported side effects included upper respiratory infection, diarrhea, nausea and high blood pressure. Report any unusual symptoms to your doctor.

ASK YOUR DOCTOR OR HEALTHCARE PROFESSIONAL ABOUT VIOXX.

Call 1-800-853-1516 for more information, or visit www.vioxx.com. Please see important additional information on the next page.

ONCE DAILY

VIOXX®

(rofecoxib)

FOR EVERYDAY VICTORIES.

9183902

Patient Information about
VIOXX® (rofecoxib tablets and oral suspension)
VIOXX® (pronounced "VI-ox")
for Osteoarthritis and Pain
Generic name: rofecoxib ("ro-fa-COX-ib")

You should read this information before you start taking VIOXX*. Also, read the leaflet each time you refill your prescription, in case any information has changed. This leaflet provides only a summary of certain information about VIOXX. Your doctor or pharmacist can give you an additional leaflet that is written for health professionals that contains more complete information. This leaflet does not take the place of careful discussions with your doctor. You and your doctor should discuss VIOXX when you start taking your medicine and at regular checkups.

What is VIOXX?

VIOXX is a nonsteroidal anti-inflammatory drug (NSAID) that is used to reduce pain and inflammation (swelling and soreness). VIOXX is available as a tablet or a liquid that you take by mouth.

VIOXX is a medicine for:
- relief of osteoarthritis (the arthritis caused by age-related "wear and tear" on bones and joints)
- management of acute pain in adults (like the short-term pain you can get after a dental or surgical operation)
- treatment of menstrual pain (pain during women's monthly periods).

Who should not take VIOXX?

Do not take VIOXX if you:
- have had an allergic reaction such as asthma attacks, hives, or swelling of the throat and face to aspirin or other NSAIDs (for example, ibuprofen and naproxen).
- have had an allergic reaction to rofecoxib, which is the active ingredient of VIOXX, or to any of its inactive ingredients. (See Inactive Ingredients at the end of this leaflet.)

What should I tell my doctor before and during treatment with VIOXX?

Tell your doctor if you are:
- pregnant or plan to become pregnant. VIOXX should not be used in late pregnancy because it may harm the fetus.
- breast-feeding or plan to breast-feed. It is not known whether VIOXX is passed through to human breast milk and what its effects could be on a nursing child.

Tell your doctor if you have:
- kidney disease
- liver disease
- heart failure
- high blood pressure
- had an allergic reaction to aspirin or other NSAIDs
- had a serious stomach problem in the past.

Tell your doctor about:
- any other medical problems or allergies you have now or have had.
- all medicines that you are taking or plan to take, even those you can get without a prescription.

Tell your doctor if you develop:
- ulcer or bleeding symptoms (for instance, stomach burning or black stools, which are signs of possible stomach bleeding).
- unexplained weight gain or swelling of the feet and/or legs.
- skin rash or allergic reactions. If you have a severe allergic reaction, get medical help right away.

How should I take VIOXX?

VIOXX should be taken once a day. Your doctor will decide what dose of VIOXX you should take and how long you should take it. You may take VIOXX with or without food.

Can I take VIOXX with other medicines?

Tell your doctor about all of the other medicines you are taking or plan to take while you are on VIOXX, even other medicines that you can get without a prescription. Your doctor may want to check that your medicines are working properly together if you are taking other medicines such as:
- methotrexate (a medicine used to suppress the immune system)
- warfarin (a blood thinner)
- rifampin (an antibiotic)
- ACE inhibitors (medicines used for high blood pressure and heart failure)
- lithium (a medicine used to treat a certain type of depression).

*Registered trademark of MERCK & CO., INC.

What are the possible side effects of VIOXX?

Serious but rare side effects that have been reported in patients taking VIOXX and/or related medicines have included:

- Serious stomach problems, such as stomach and intestinal bleeding, can occur with or without warning symptoms. These problems, if severe, could lead to hospitalization or death. Although this happens rarely, you should watch for signs that you may have this serious side effect and tell your doctor right away.

- Serious allergic reactions including swelling of the face, lips, tongue, and/or throat which may cause difficulty breathing or swallowing occur rarely but may require treatment right away. Severe skin reactions have also been reported.

- Serious kidney problems occur rarely, including acute kidney failure and worsening of chronic kidney failure.

- Severe liver problems, including hepatitis and jaundice, occur rarely in patients taking NSAIDs, including VIOXX. Tell your doctor if you develop symptoms of liver problems. These include nausea, tiredness, itching, tenderness in the right upper abdomen, and flu-like symptoms.

In addition, the following side effects have been reported: confusion, hair loss, hallucinations, low blood cell counts, unusual headache with stiff neck (aseptic meningitis).

More common, but less serious side effects reported with VIOXX have included the following:

Upper and/or lower respiratory infection and/or inflammation
Headache
Dizziness
Diarrhea
Nausea and/or vomiting
Heartburn, stomach pain and upset
Swelling of the legs and/or feet
High blood pressure
Back pain
Tiredness
Urinary tract infection.

These side effects were reported in at least 2% of osteoarthritis patients receiving daily doses of VIOXX 12.5 mg to 25 mg in clinical studies.

The side effects described above do not include all of the side effects reported with VIOXX. Do not rely on this leaflet alone for information about side effects. Your doctor or pharmacist can discuss with you a more complete list of side effects. Any time you have a medical problem you think may be related to VIOXX, talk to your doctor.

What else can I do to help manage my osteoarthritis pain?

Talk to your doctor about:
- Exercise
- Controlling your weight
- Hot and cold treatments
- Using support devices.

What else should I know about VIOXX?

This leaflet provides a summary of certain information about VIOXX. If you have any questions or concerns about VIOXX, osteoarthritis or pain, talk to your health professional. Your pharmacist can give you an additional leaflet that is written for health professionals.

Do not share VIOXX with anyone else; it was prescribed only for you. It should be taken only for the condition for which it was prescribed.

Keep VIOXX and all medicines out of the reach of children.

Inactive Ingredients:

Oral suspension: citric acid (monohydrate), sodium citrate (dihydrate), sorbitol solution, strawberry flavor, xanthan gum, sodium methylparaben, sodium propylparaben.

Tablets: croscarmellose sodium, hydroxypropyl cellulose, lactose, magnesium stearate, microcrystalline cellulose, and yellow ferric oxide.

Issued July 2000

MERCK & CO., INC.
Whitehouse Station, NJ 08889, USA

004271(3)(902)-VIO-CON

nationalgeographic.com

Webscapes

■ NEW CHANNEL

Our new TV presence, National Geographic Channel, launches on January 7. Join the celebration online.
nationalgeographic.com

■ THE WHITE HOUSE

It's your first day as President of the United States. Savor it. Then set up your interactive Oval Office and take charge.
. . . /whitehouse

■ DOWN UNDER

Join photographer David Doubilet in a jaw-dropping underwater tour of Australia's Great Barrier Reef (pages 30-57)—his "assignment of a lifetime."
. . . /ngm/0101

■ SURVIVING SPACE

Author Michael E. Long and photographer Cary Wolinsky (pages 6-29) share tales of life on assignment.
. . . /ngm/0101

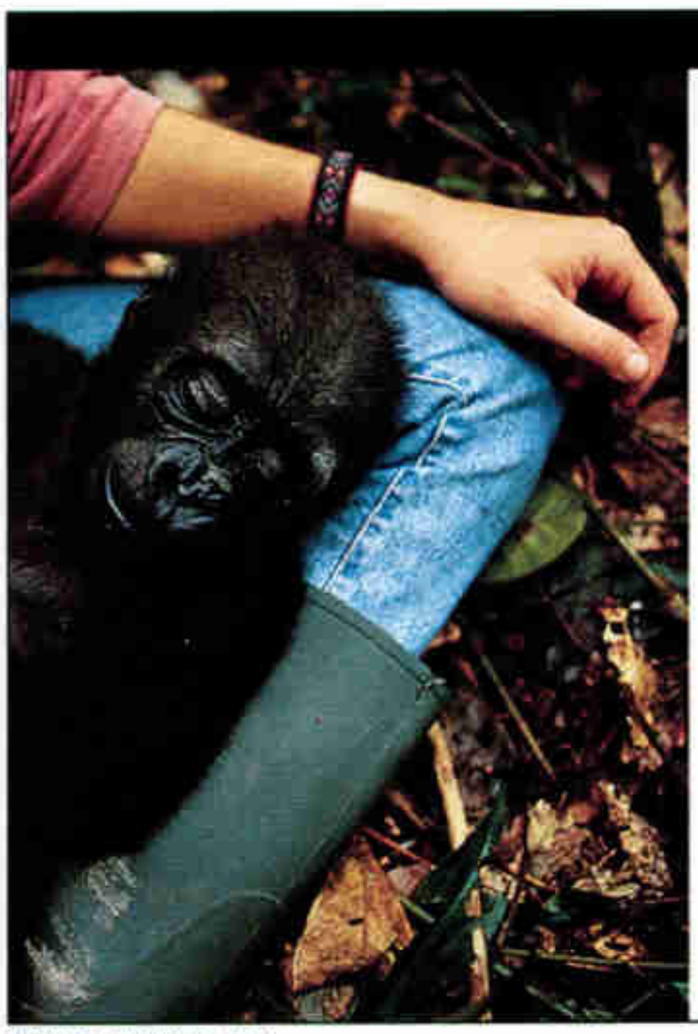
■ FOR KIDS

Enter the world of polar bears. Find out what they eat, what they do for fun, and how they survive those icy temperatures.
. . . /kids/creature_feature/0004/polar.html

E-mail:
online@nationalgeographic.com

Register for our e-mail newsletter:
nationalgeographic.com/community/register.html

E-mail for Member Services:
ngsline@customersvc.com



MICHAEL NICHOLS, NGS

EarthPulse

Our new conservation features include the WildWorld interactive atlas and a Heroes for the Planet contest. The atlas, developed with the World Wildlife Fund, covers world ecosystems like this gorilla's African home. In partnership with Ford Motor Company, we will send contest winners on an explorer-led expedition. Details at *nationalgeographic.com/earthpulse*.

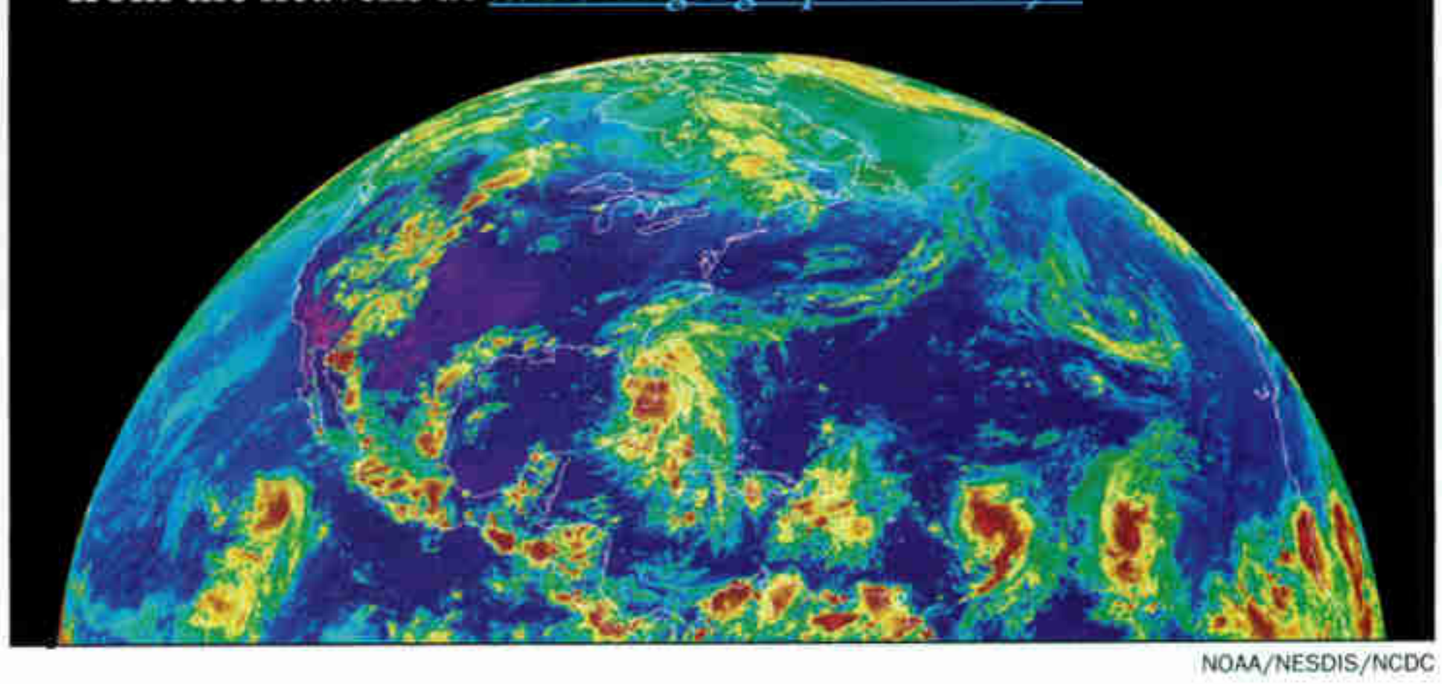
Imperial Palace

Decorum is everything in Japan's Imperial Palace (pages 94-123). Executive Editor Robert Poole and staff photographer Sam Abell used a lot of polite doggedness to get behind the "chrysanthemum curtain." Read Poole's impressions of traditional *gagaku* music, and listen in at *nationalgeographic.com/ngm/0101*.

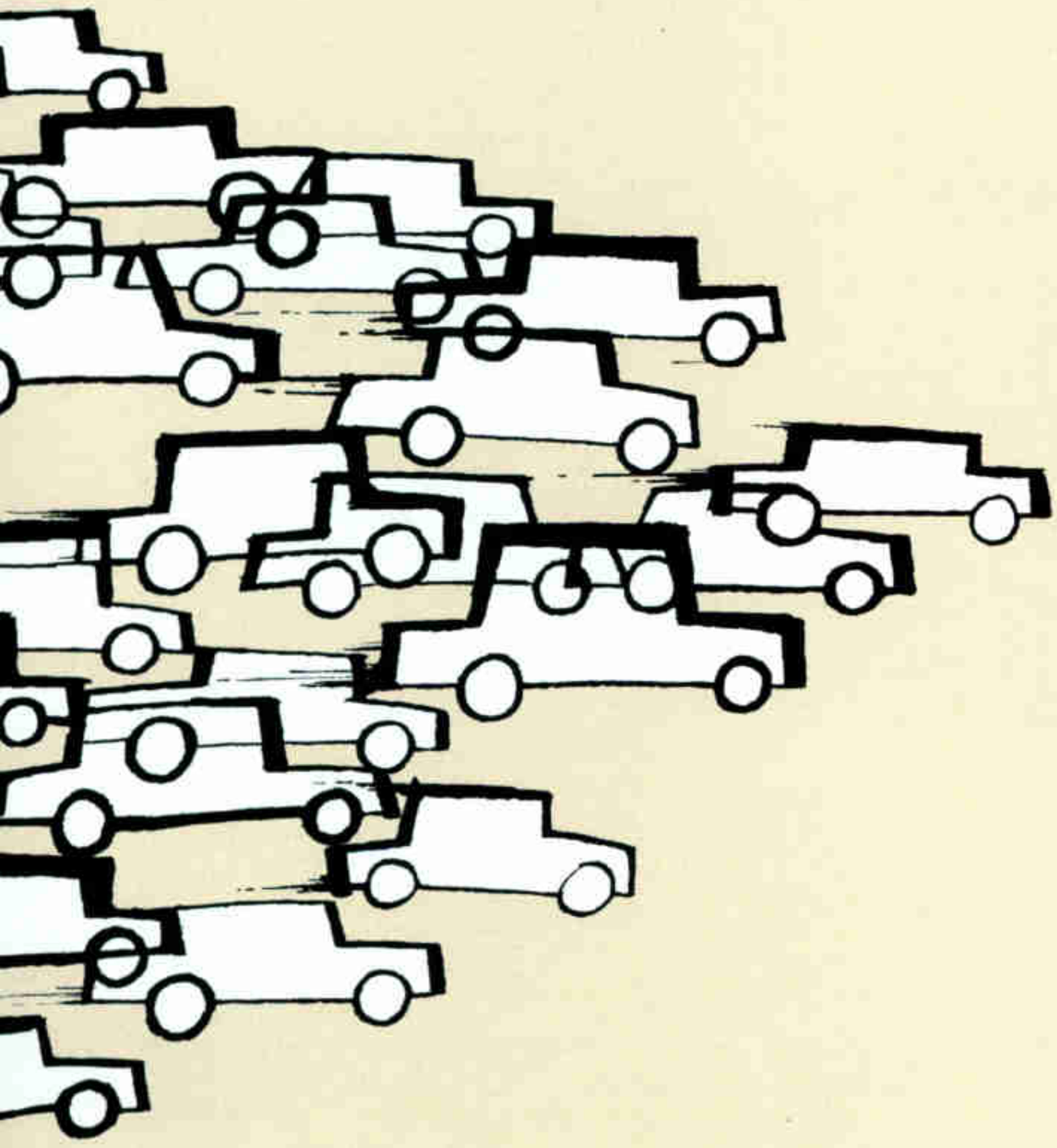
SAM ABELL, NGS

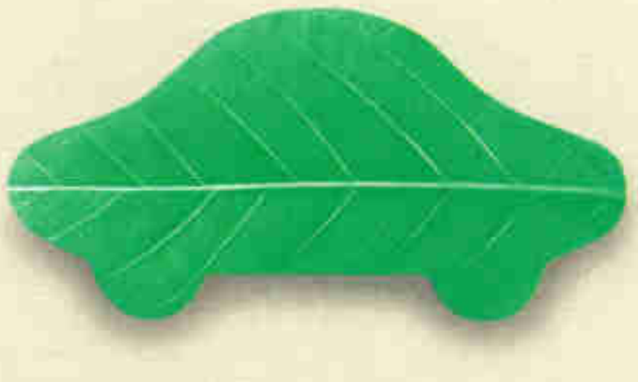
Eye in the Sky

Climb aboard a satellite to see the impact of weather, wars, earthquakes, and deforestation. Audio and video functions and animation give you a view from the heavens at *nationalgeographic.com/eye*.



NOAA/NESDIS/NCDC





Did you ever have the feeling
you were being followed?

It seems everyone has been talking about greener cars these days. But we've done more than just talk. In 1997 we introduced the Toyota Hybrid System. Now it is the power inside the world's first mass-produced gas/electric vehicle, the Prius. As the automotive industry lines up behind us, we have already begun developing the next generation of environmental vehicle technology. The lights are green. Let's go. www.toyota.com/ecologic 800-GO-TOYOTA ©2000

TODAY TOMORROW TOYOTA

National Geographic TV

Watch the new National Geographic Channel beginning JANUARY 7

ELIZABETH PARER-COOK

NATIONAL GEOGRAPHIC CHANNEL, JANUARY 29

Killer Whales

Slicing through the waters of British Columbia's Johnstone Strait, killer whales display both power and beauty as they set their course for a summer of hunting and breeding. *Killer Whales: Wolves of the Sea,* a dramatic look at orcas, leads off *Living Wild,* a series featuring rarely witnessed scenes of animal behavior from National Geographic's incomparable film vault. The series airs weeknights at 8 ET/PT.

NATIONAL GEOGRAPHIC CHANNEL, JANUARY 7

America's Home

From the Oval Office to the kitchen, *Inside the White House* is the ultimate tour. The film opens the *National Geographic Presents* series, broadcast Sundays at 8 p.m. ET/PT.

JAMES L. STANFIELD (ABOVE); MARGARET SIDLOSKY, NGS STAFF

EXPLORER, CNBC, JANUARY 7 AND 13

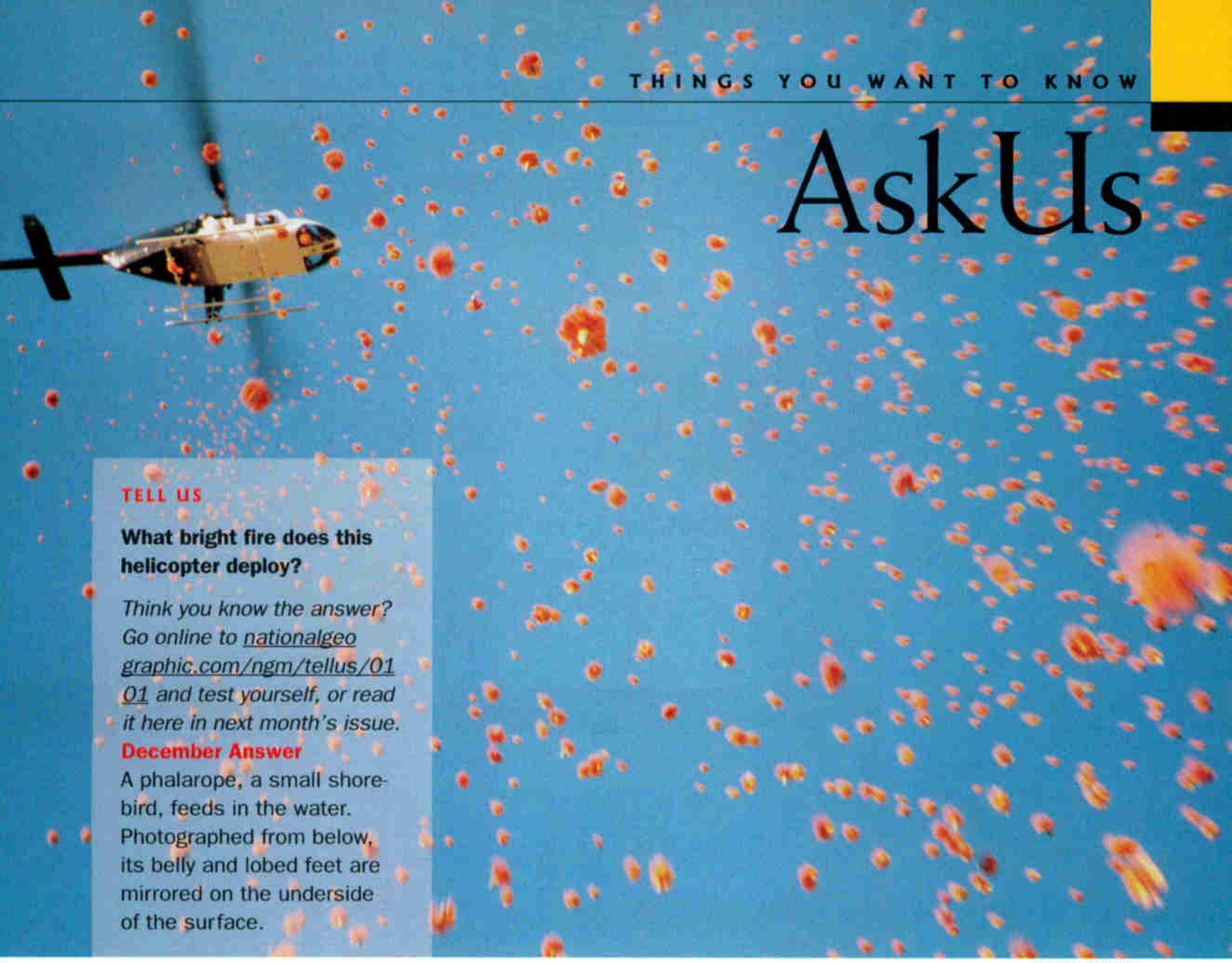
World's Most Valuable Fish

Fast, powerful—and delicious—the bluefin tuna excites the interest of fishermen and scientists alike. *In Pursuit of the Giant Bluefin* examines the habits and perils of what biologists call "the ultimate fish." Action ranges from Tokyo's fish market (above), where a tuna can fetch $80,000, to the ocean feeding grounds of one of the sea's great hunters.

National Geographic EXPLORER CNBC. Weekends, 8 p.m. ET/PT. **National Geographic Specials** See local listings. **National Geographic Videos, Kids Videos, and DVDs** Call 1-800-627-5162. **National Geographic Channel** Call your local cable or satellite provider.

■ Programming information accurate at press time; consult local listings or our website at nationalgeographic.com.

Ask Us



TELL US

What bright fire does this helicopter deploy?

Think you know the answer? Go online to nationalgeographic.com/ngm/tellus/0101 and test yourself, or read it here in next month's issue.

December Answer

A phalarope, a small shorebird, feeds in the water. Photographed from below, its belly and lobed feet are mirrored on the underside of the surface.

J. FINKELSTEIN-FORD

THE ANSWER PLACE

Our Research Correspondence staff responds to questions from curious readers.

Q How many man-made satellites are in orbit around the Earth?

A The United States Space Command in Colorado reports that 2,698 satellites were aloft as of September of last year, but only about a third were still functioning. The remaining "dead" craft have spent their fuel. Orbiting objects without power experience a deterioration in orbit, fall back toward Earth, and burn up upon reentering the atmosphere. When this happens, the Space Command takes notice and marks the item off its satellite box score.

Q How does thunder start?

A When lightning flashes across the sky, it heats the air in its path to temperatures as high as 55,000°F (30,500°C)—over five times hotter than the surface of the sun. The air expands at supersonic speed, sending off shock waves that weaken into sound waves and greet us as the boom of thunder. Because sound travels more slowly than light, you can tell how far you are from lightning by counting the seconds until you hear the thunder. Five seconds represents a distance of about a mile.

MORE INFORMATION

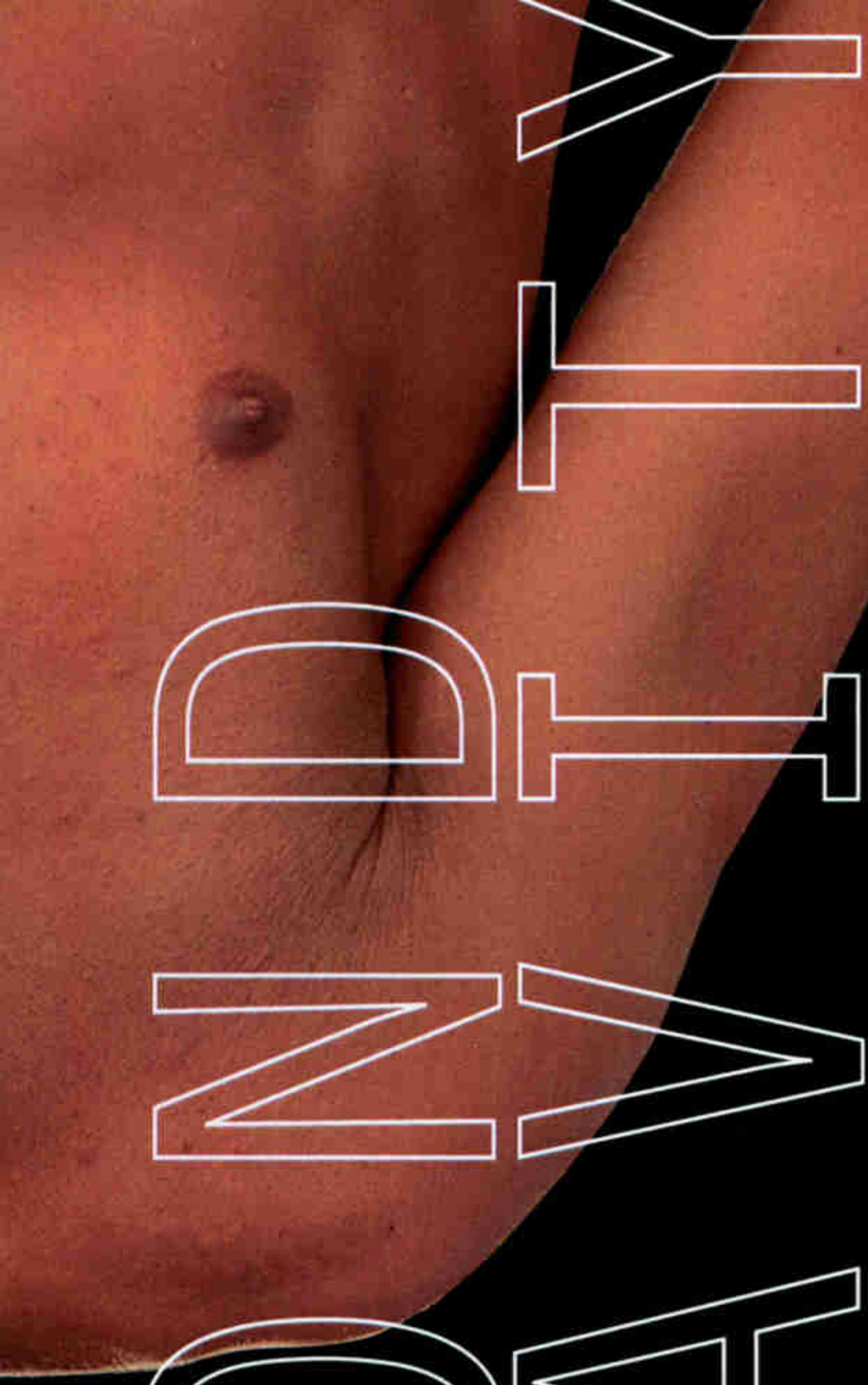
Send questions to **Ask Us, National Geographic Magazine, PO Box 96095, Washington, DC 20090-6095** or via the Internet to **ngsaskus@nationalgeographic.com**. Include name, address, and daytime phone number.

CARTOGRAPHIC

Q What is the longest mountain range in the world?

A The Andes is the longest range above sea level, but the Mid-Atlantic Ridge runs along the Atlantic Ocean floor from Iceland to near the Antarctic Circle.

NG MAPS; IMAGE SOURCE: NOAA



THE DEATH OF EVEREST

BY SIR ARTHUR CLARKE

One weekend in 1939, shortly before the outbreak of World War II, visitors to London's Science Museum might have come across a dozen young men peering through a contrivance of rotating mirrors at a spinning disk a few meters away. Hanging just above them was the 1903 Wright Flyer—but the experimenters had set their sights on something far more ambitious than flight in the atmosphere. They believed that one day it would be possible to travel to other worlds and were trying to design the navigational equipment needed for such voyages.

I am now the only survivor of that little group of British Interplanetary Society members. Though none of us could have guessed that the first moon landing was only three decades in the future, we were already concerned with the problems that might arise during the voyage. One of these—well known even to Jules Verne when he wrote *From the Earth to the*

There is nowhere beyond the Earth, as far as which unprotected humans can survive.

Moon in 1865—was that for most of the time the occupants of a spaceship would be weightless.

Because this condition cannot be reproduced on Earth for more than a few seconds, no one knew how the human body would react to it. Some horrifying scenarios had been predicted: One held that the heart would race uncontrollably in zero gravity, so that any foolhardy astronauts could expect a swift but merciful death.

However, there appeared to be a simple solution: Make the living quarters of the spaceship a slowly revolving drum, so that centrifugal force gave the occupants the sensation of weight, allowing them to walk on a cylindrical "floor." My late friend Stanley Kubrick showed this, on a rather lavish scale, in *2001: A Space Odyssey*'s orbiting Hilton hotel.

So we premature 1930s space cadets had designed a spinning spaceship, but how to observe the moon and stars if we were revolving several times a minute? Fortunately, astronomers had long ago solved this problem for the Earth, which revolves once a day, with an instrument known as a coelostat. This employs mirrors moving in such a way that the reflected sky appears stationary.

To demonstrate the British Interplanetary Society's considerably higher speed version, we used a spinning disk on which we had painted the letters "BIS." These were quite unreadable until one peered into the coelostat, where they appeared motionless. I am indeed happy to say that the society is still very active and is now the world's oldest organization devoted to space exploration.

As it turned out, our fears of weightlessness were much exaggerated, although there may be long-term effects about which little is yet known. Humans have now lived in space for longer than a year, and indeed some astronauts became so addicted to freedom from gravity that they were reluctant to return to Earth.

Weightlessness does have certain problems, however, and NASA's famous—or infamous—flying laboratory, the aptly named "Vomit Comet," has been used to study some of them. The plane's carefully controlled flight pattern can produce weightlessness for nearly half a minute. One of the great unsung moments in the conquest of space was when the Vomit Comet was used to test space-toilet design. The heroic volunteers had a mere 30-second window of opportunity. . . .

It is fortunate that the only planets in the solar system with gravity greater than Earth's are the gas giants Jupiter and Neptune, which have no solid surfaces and so are unlikely targets for future explorers. On the moon and Mars—the two most promising destinations—gravity is one-sixth and one-third Earth's, so we would have a reassuring feeling of enhanced strength there. However, should permanent settlements be established, any children born on those worlds may never be able to risk visiting the home planet. In the centuries to come we may therefore see a form of gravitational segregation, as our species divides into various tribes,

we know, where we will find environments in

adapted to zero, fractional, and one gravity.

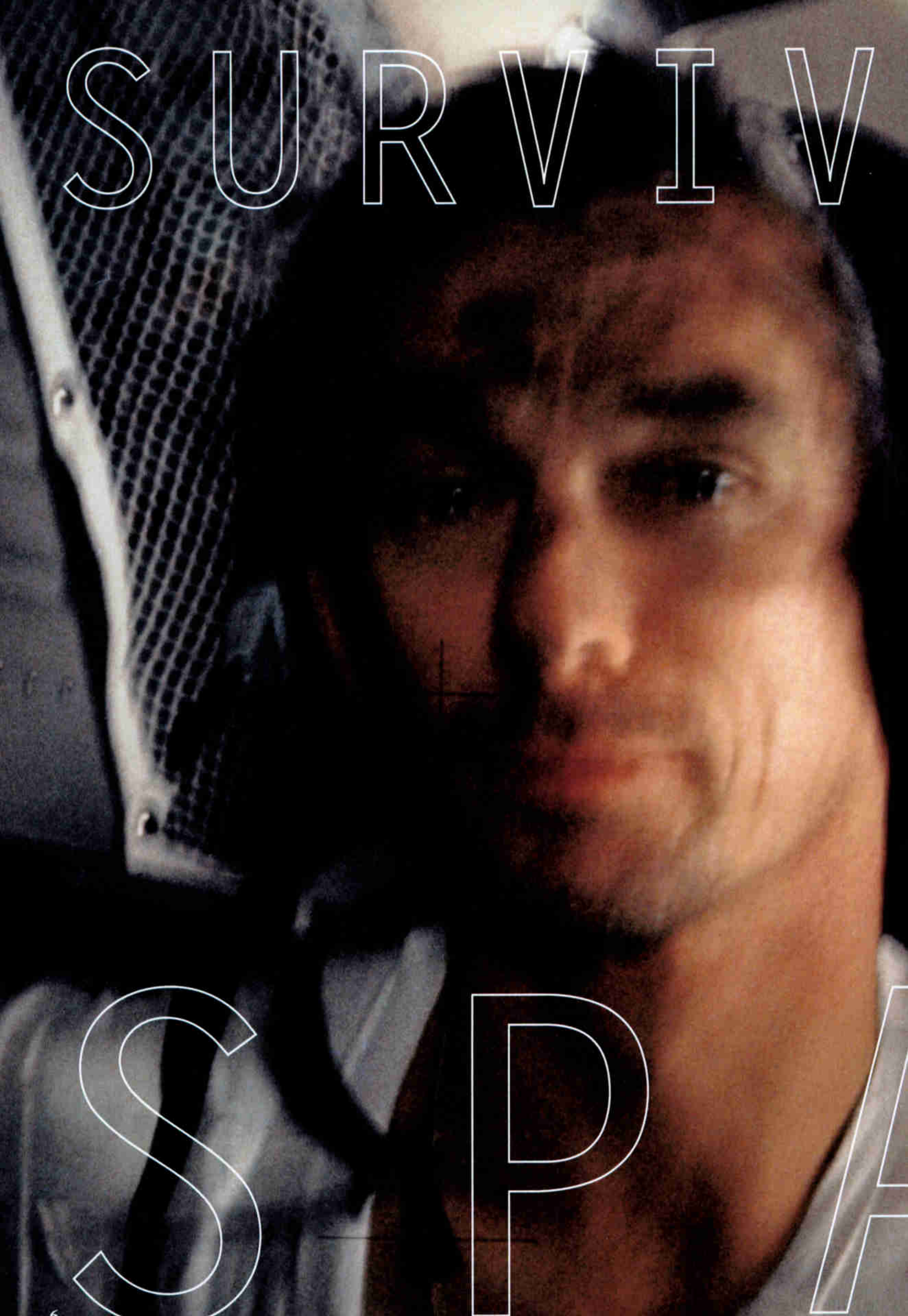
There is nowhere beyond the Earth, as far as we know, where we will find environments in which unprotected humans can survive. Sometime in this millennium we will confront this dilemma: Should we leave our planetary neighbors unaltered, or should we modify them and make them closer to the heart's desire? With technologies that have already been the subject of much study, "terraforming"—a word invented in the 1940s by science fiction writer Jack Williamson—would be feasible for some of the bodies in the solar system. Thus we might orbit giant solar mirrors to warm frozen Mars, or sunshades to cool torrid Venus. Environmental groups, rightly pointing out the mistakes we have made on this planet, will have much to protest in the exciting centuries to come.

Barring catastrophes—natural or man-made—the third millennium will be the real age of space. Sooner or later today's hopelessly inefficient rockets (with payloads measured in fractions of a percent!) will be superseded by technologies that will make space travel no more expensive than atmospheric flight. The real cost, in terms of energy, of putting a human into orbit will be only a few hundred dollars, not the present millions of dollars. One way of approaching this target would be to use a "space elevator," which would lift people into space using cables lowered from satellites in geostationary orbit, as I described in my novel *The Fountains of Paradise.*

What we may discover during the forthcoming exploration of the solar system will shape the future of humanity. And beyond the planets lies the inconceivably vaster universe of stars and galaxies. Though we may well be the only children of this particular sun, can we be egocentric enough to believe that self-styled *H. sapiens* is the single intelligent life-form the cosmos has produced in billions of years on trillions of worlds?

The truth is indeed out there, and one day we will find it—or it will find us. Then we will learn whether we are closer to the angels or the apes. □

PHOTOGRAPHS BY CARY WOLINSKY
(PRECEDING PAGES AND SOYUZ SPACE SUIT ABOVE)


SURVIV
&PA

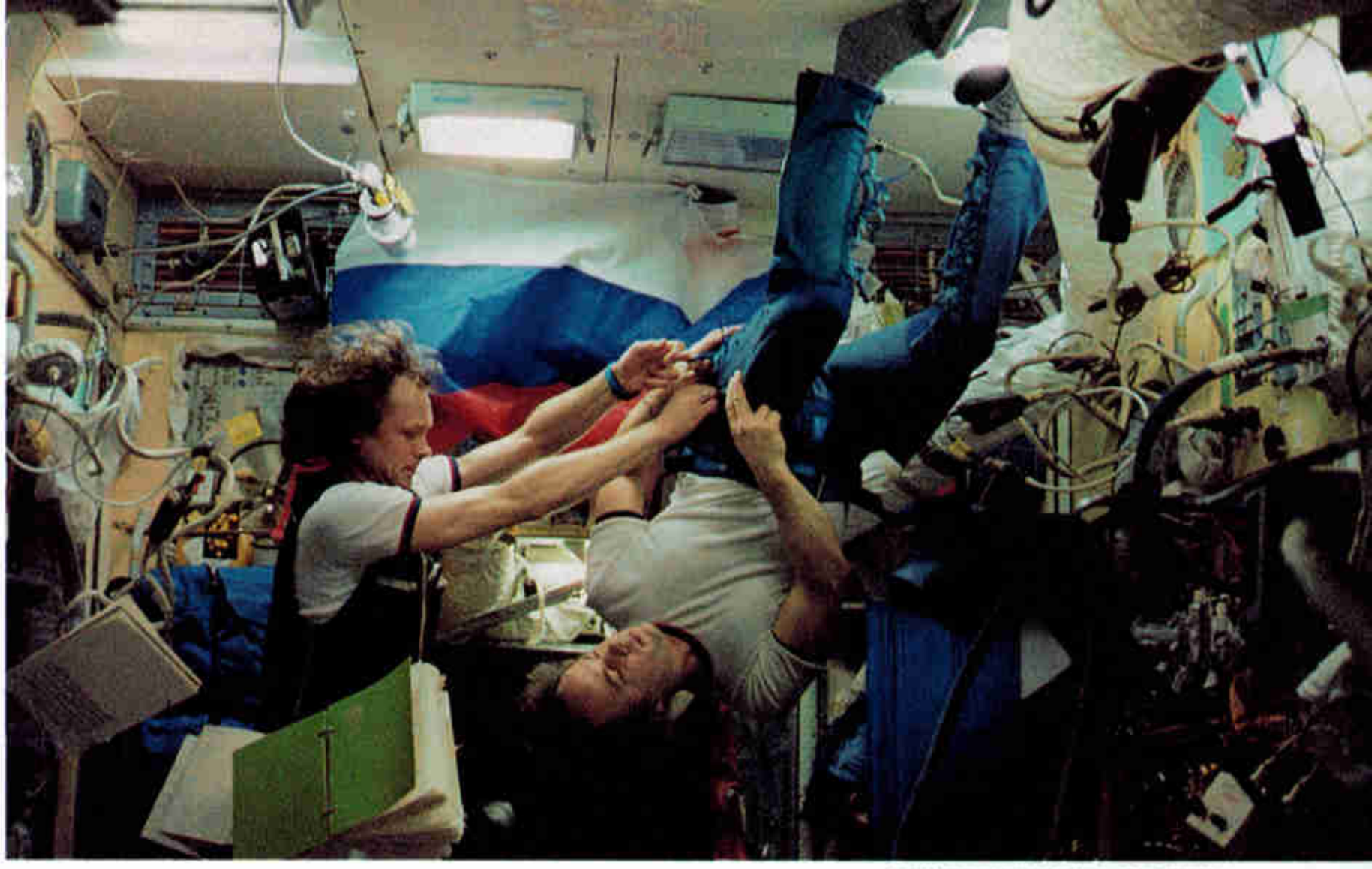
I N G I N

Three days on the moon in the final Apollo mission, in 1972, leave astronaut Eugene Cernan weary and filthy with rock dust. A three-year trip to Mars multiplies the hazards of space travel, confronting NASA with a troubling scenario. Imagine a radiation-sick, sleep-deprived astronaut stepping on Mars. Muscle-and-bone-weakened, immune-system-challenged, he faints and breaks a leg. What now, Houston?

[BY MICHAEL E. LONG • PHOTOGRAPHS BY CARY WOLINSKY]

A C E

NASA



ALEXANDER VIKTORENKO COLLECTION

[WEIGHTLESSNESS SYNDROMES] Yawning as he is raised up after 16 days in bed to simulate weightlessness, a paid volunteer (left) feels faint, as many astronauts do on returning to Earth's gravity. The Harvard Medical School study seeks to learn why some space-conditioned bodies don't move enough blood to the brain to prevent fainting. Weightlessness can also complicate the simplest acts, such as donning trousers aboard Mir, the Russian space station (above).

Boarding a bus at the Gagarin Cosmonaut Training Center north of Moscow, 11 German tourists chat excitedly about their holiday—Russia's aerospace holiday, where you trade cash for thrills and spills. Three men report that tomorrow they will have a ride in the MiG-21 fighter ($4,000 apiece). A slender woman wearing thick glasses and a buzz cut reveals that she is going to do the centrifuge ($2,000), a whirling device that will subject her to perhaps 5 g's, or five times the force of gravity.

Right now they're all experiencing the 1 g common to Earthlings but are looking forward to a dose of zero gravity (for $1,500 a head) that produces weightlessness or, as the Germans call it, *Schwerelosigkeit.* At Chkalovsky Air Force Base they enter the huge cargo bay of a four-engine Ilyushin-76 MDK. The brilliantly white aircraft surges down the runway, engines screaming.

At altitude a steep 45-degree climb begins. Bright lights come on, and the pilot says, "Prepare for zero gravity," then lowers the nose of the airplane to produce about 30 seconds of weightlessness. Magically, we all rise like smoke and float and fly around. Just like that. People wriggling, eyes wide, mouths open, faces smiling, frowning. Bodies turning upside down—a stunning sight that my eyes record but that my brain seems unable to interpret. Maj. Boris V. Naidyonov of the Russian Air Force, my instructor, asks, "You OK?" He is concerned about nausea, and so am I. "I think so," I reply.

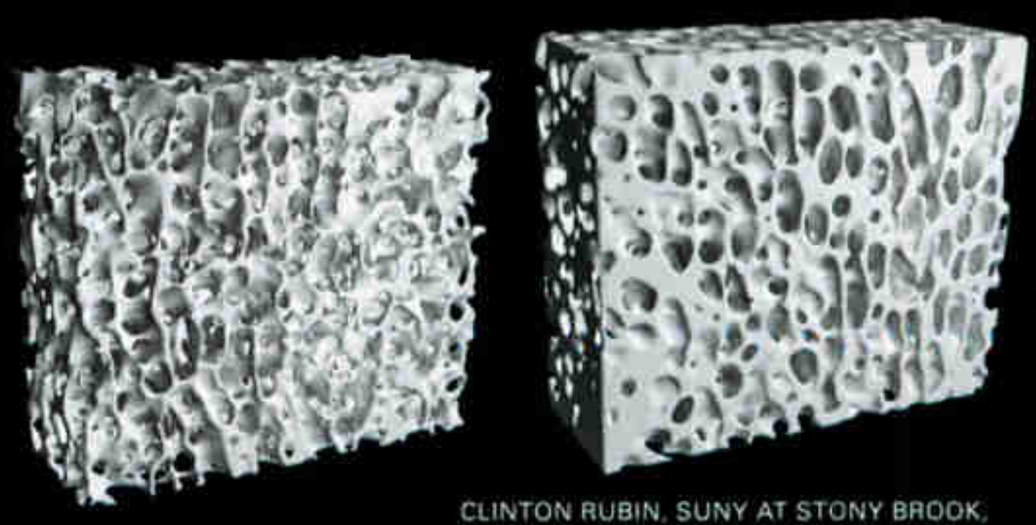
During other zero-gravity periods, one of my companions ricochets off the ceiling. Another does weightless gymnastics. Naidyonov tosses me around the cargo bay like a javelin, twirls me like a baton. This is serious fun, as exhilarating as the airborne maneuvers I've taught as an aerobatics flight instructor.

But the slender woman with the buzz cut and two others are silently vomiting into plastic bags. The remainder of the group, while not overtly sick, seem to have lost interest in Schwerelosigkeit.

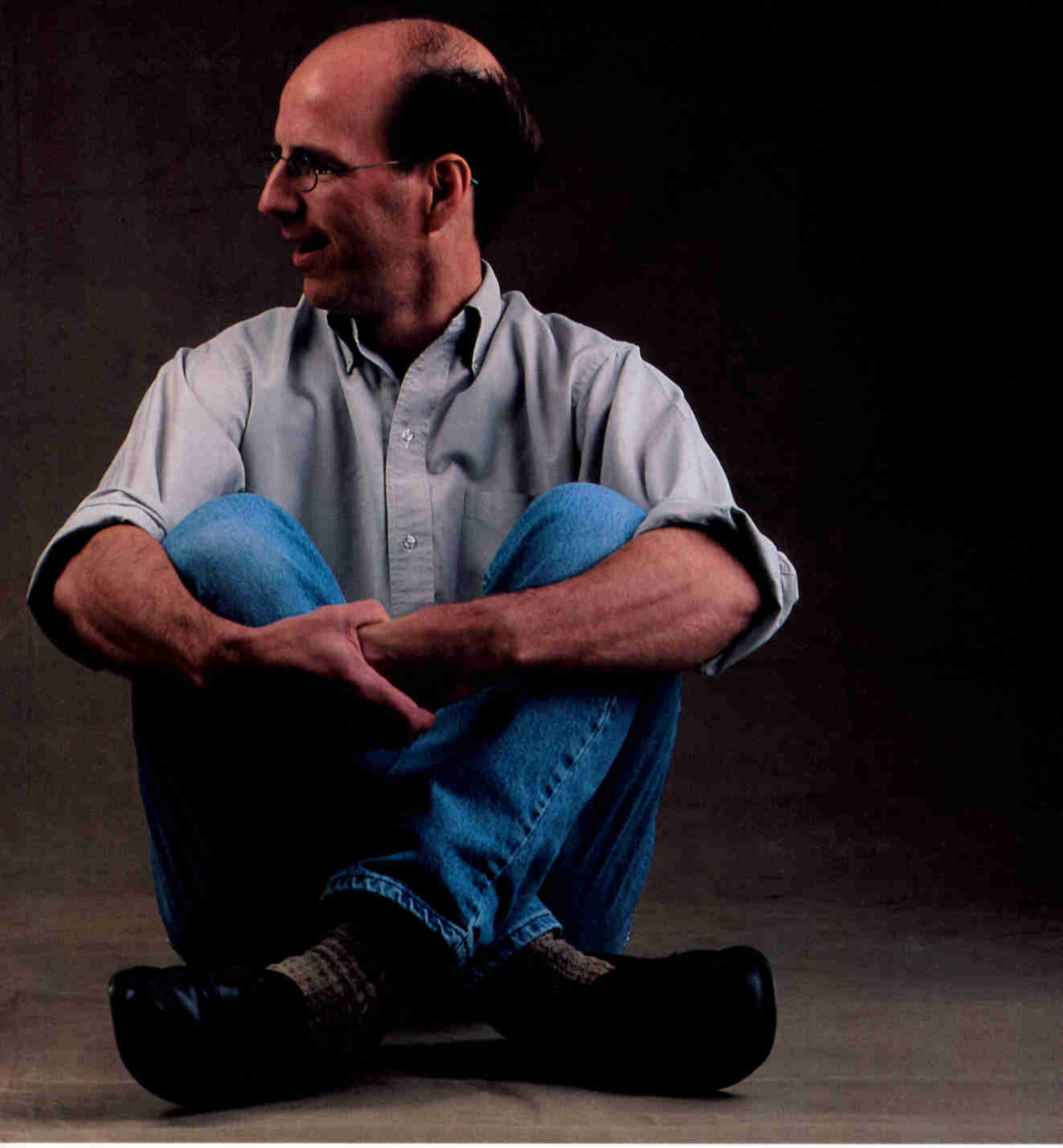
They are experiencing the motion sickness that afflicts more than two-thirds of all astronauts

[A BETTER WISHBONE]

A turkey standing on a platform receives slight vibrations that stimulate muscle and bone interaction to promote bone growth. Clinton Rubin of SUNY at Stony Brook also experiments with larger subjects. After a year of daily 20-minute sessions on such a vibrating platform, a sheep showed the robust striations of increased density (far right). A sheep that had stayed in pasture showed normal bone (near right). Rubin's procedure may one day become part of an exercise program to preserve astronauts' bones, which typically decline in strength.



CLINTON RUBIN, SUNY AT STONY BROOK, AND RALPH MULLER, HARVARD MEDICAL SCHOOL



upon reaching orbit, even veteran test pilots who have never been airsick. Though everyone recovers after a few days in space, body systems continue to change.

Deprived of gravity information, a confused brain engenders visual illusions. Body fluids surge to chest and head. Neck veins bulge. Faces puff. The heart enlarges a bit, as do other organs. Sensing too much fluid, the body begins to excrete it, including calcium, electrolytes, and blood plasma. The production of red blood cells decreases, rendering astronauts slightly anemic. With the loss of fluid, legs shrink. Spinal discs expand, and so does the astronaut—a six-footer can soon measure six-foot-two and suffer a backache.

In an astounding feat of adaptation, Earthlings are becoming spacelings, and though the process may sound terrible, astronauts adjust to it, come to enjoy it, and seem no worse for wear—at least for short missions such as space shuttle flights that last a week or two.

During longer flights, however, physiology enters an unknown realm. As director of

Russia's Institute for Biomedical Problems from 1968 to 1988, Oleg Gazenko watched cosmonauts return from long flights wobbly, pale, unable to stand without fainting, needing to be carried from the spacecraft. "We are creatures of the Earth," Gazenko told me. "These changes are the price for the ticket to space."

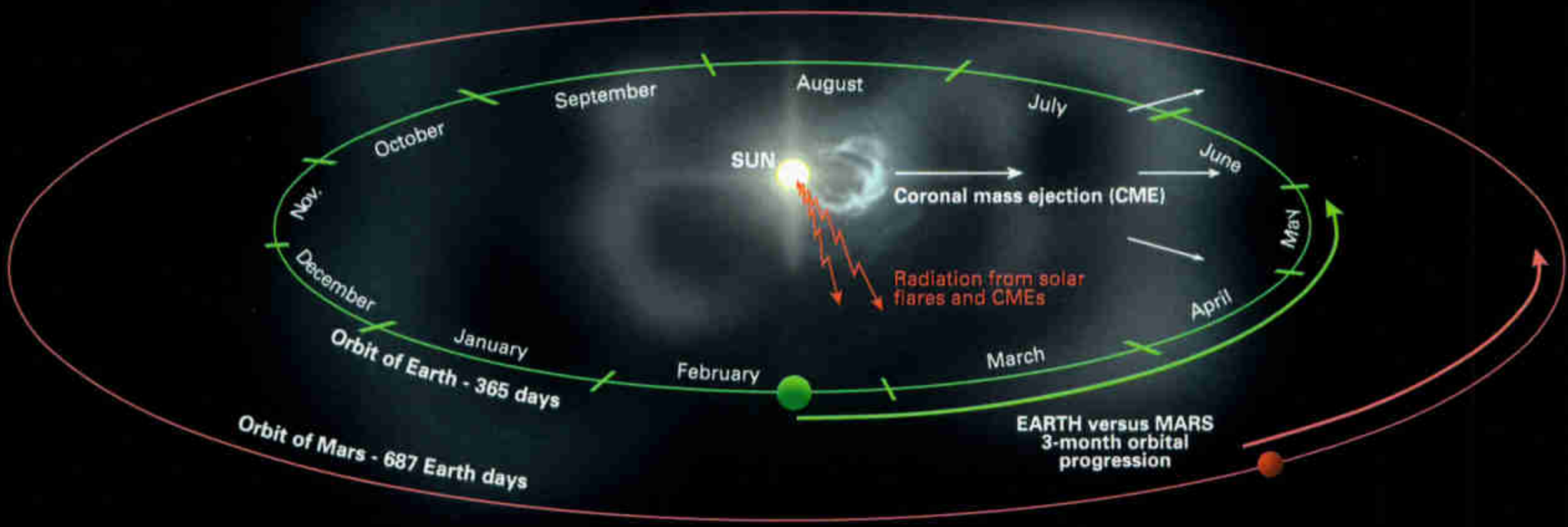
Americans returning from months-long flights on Mir, the Russian space station, also paid a price, suffering losses in weight, muscle mass, and bone density. NASA geared up to see how—even if—humans would survive the most demanding of space ventures, a mission to Mars, which could last as long as three years. Many biomedical problems could compromise a mission. During long-duration spaceflight the heart loses muscle mass, while the large weight-bearing muscles of the legs gradually atrophy, having little work to do in the absence of gravity. Density in such bones as the pelvis and legs relentlessly decreases—1 to 2 percent a month on average—about what a postmenopausal woman might lose in a year.

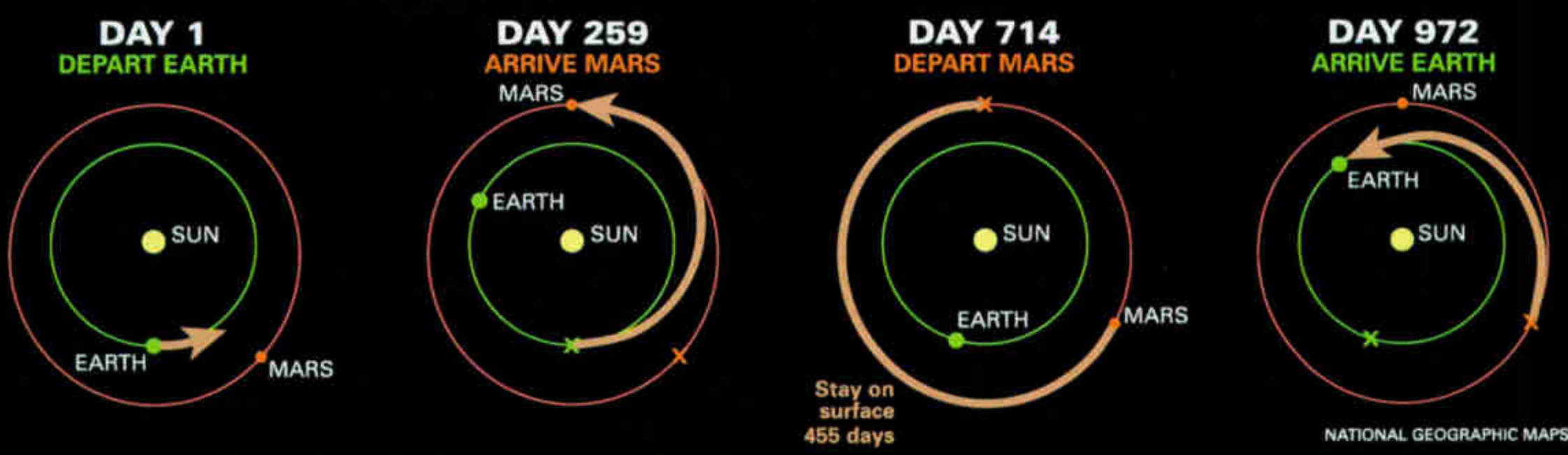
Waiting in ambush beyond the shield of Earth's atmosphere, solar and galactic radiation can pepper an astronaut's body like machine-gun fire. Radio communications to Earth and back from a Mars crew will take as long as 40 minutes, leaving astronauts pretty much on their own. Confined to a spacecraft roughly the size of two motel rooms, how will they get along with each other? And with themselves—what about loneliness, depression, and medical emergencies?

"If something bad happens to astronauts in low Earth orbit, we can bring them back to Earth quickly," says *(Continued on page 20)*

[THREE YEARS OUT AND BACK]

Traveling between Earth and Mars will require lots of fuel and good timing, if not new rockets, as some experts say. The most fuel-efficient trajectory with today's rockets occurs when Earth is at a six-o'clock position at launch (below) and Mars is at about four o'clock—a juxtaposition that occurs just once every 26 months. The first leg will take 259 days. Come what may on the surface, astronauts must wait on Mars for their launch toward home until Earth is in alignment. Total mission time: 972 days (bottom).





[MARS ON EARTH]

Walking through a simulated Mars landscape at NASA's Johnson Space Center, an Earthling demonstrates the mobility of a prototype space suit. He steps over a large rock (above) in a suit that allows the upper body to turn, wrists to rotate, and legs to bend. (Early, stiff-suited Apollo astronauts could not bend at the waist.) For Martian realism, volcanic rocks were imported from New Mexico.

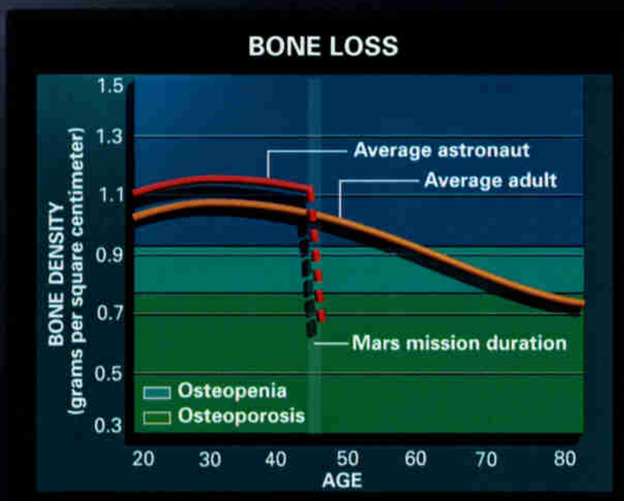
[DISORIENTATION]

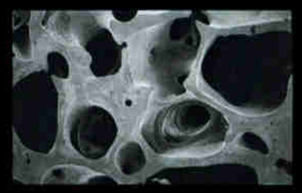
Spacefarers usually become disoriented. Without gravity there is no "up" or "down." The inner ear sends confusing data to the brain, while eyes play tricks with visual illusions. For many astronauts the sensory mix-up brings temporary nausea.

[THE BODY IN SPACE]

From bones to balance to tiny cells, scarcely any system in the body remains unaffected by weightlessness. Yet astronauts adjust quickly and come to enjoy the freedom of zero gravity, save for the threat of solar and galactic radiation that can devastate human tissue and genes. When astronauts return to Earth, their space-adapted systems must learn to cope again with gravity.

ART BY JOHN JUDE PALENCAR; GRAPHICS BY TIMOTHY ALT; OVERALL CONSULTANT: JOAN VERNIKOS, NASA LIFE SCIENCES; BONE-LOSS CHART: JAY SHAPIRO, UNIFORMED SERVICES UNIVERSITY OF THE HEALTH SCIENCES; BONE PHOTOGRAPHS: D. W. DEMPSTER, JOURNAL OF BONE AND MINERAL RESEARCH; RADIATION CHART AND DNA: FRANCIS CUCINOTTA, JOHNSON SPACE CENTER, NASA, AND PREM SAGANTI, LOCKHEED MARTIN





Healthy bone

Damaged bone

[BONE LOSS]

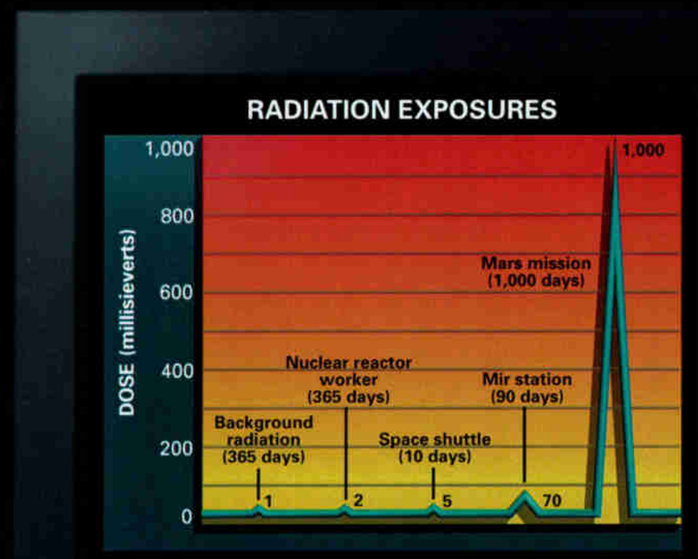
Healthy astronauts have strong bones (right, upper) until they go into space, where weightlessness triggers bone loss. Density in weight-bearing bones declines at the rate of 1 to 2 percent a month. During a mission to Mars, a 45-year-old could see bone deterioration reach the weakened state of severe osteoporosis (right, lower).

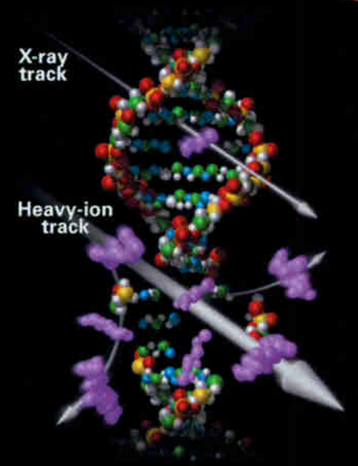
[OTHER CHANGES]

Body fluids surge to the chest and head, puffing the face and shrinking the legs. The body responds by excreting fluids containing sodium and calcium; red blood cells decrease, leaving astronauts anemic. The heart enlarges and then shrinks; spinal disks expand; cells can lose structure. The immune system and support muscles weaken. Sleep patterns are disturbed, for reasons not understood, limiting astronauts to six hours of sleep a day.

[RADIATION DAMAGE]

Radiation exposure for Mars astronauts is far greater than on the Earth's surface or in orbit (graph, below) because a Mars vehicle will no longer be shielded from galactic and solar radiation by Earth's magnetic field and atmosphere. How does that translate to cancer risk? Experts have no answer.





Supernovae forge heavy ions—atoms heavier than helium and shorn of electrons—that bombard cells in a branching pattern, causing breaks in DNA. X-rays pierce like arrows. Both can cause genes to mutate.

[KING OF

Russian cosmonaut Valery Polyakov peers from Mir (left) in 1995. The picture was taken by an approaching cosmonaut, Vladimir Titov, who used a famous Russian movie line: "Valery, please show your little face! I cannot wait to see you." Polyakov was about to set the record for space flight—437 days. He landed to plaudits and helping hands in Kazakhstan (right).

NASA (FAR LEFT); MARSEL GUBAIDULLIN, STAR CITY (BELOW)

SPACE TRAVEL]

Suffering bone loss but still fit after two hours of exercise a day, the physician-cosmonaut walked away under his own power.

A picture with his wife, Nelly (above, center), anchors a montage of family pictures and a favorite icon that he carried on his long flights. Such personal items helped him stay positive and mentally focused.

Polyakov recalls a fire on Mir sparked by an oxygen cylinder. He smothered the spreading flames with space suits. When the fire was extinguished, he took the icon into an adjoining room and began to pray.

Later, on a trip to Washington, D.C., Polyakov met veteran astronaut John Glenn. "John," he asked, "would you like to fly to Mars?" Glenn replied, "With you, Valery, anytime."

(Continued from page 12) Jeffrey Sutton, professor at the Harvard-MIT Division of Health Sciences and Technology. "That won't be possible when they're en route to Mars." Once launched on a trajectory to Mars, they're stuck on a round-trip journey that could take as long as three years.

Preoccupied with the demands of building the International Space Station, NASA has no Mars mission on the books. When I talked to NASA astronauts and scientists, though, I saw the gleam in their eyes. "I'd go to Mars in a minute," said astronaut Shannon Lucid, holder of the American record of 188 days in orbit.

These appetites were whetted last June when scientists reported indications of water, the broth of life, on Mars. But before a Mars mission can happen, experts agree, the physiology questions must be addressed. Gloomy premonitions are afoot: A sleep-deprived astronaut with weak muscles and bones and a weakened immune system takes a radiation hit en route. Upon landing he faints and breaks a leg, which renders him helpless and a distraction to his fellow astronauts. Stressed in their cramped quarters, the crew bicker among themselves and argue with mission control back on Earth. The mission is threatened.

A worst-case scenario, to be sure, but these things can happen in space, and some already have. At the Massachusetts Institute of Technology, astronaut David A. Wolf, who spent four and a half months on Mir, told aerospace students how weak he was on landing—"I had lost 40 percent of my muscle mass, 12 percent of my bone, and 23 pounds." Wolf's space-adapted balance system, dealing once again with gravity, gave him trouble turning corners and had him "running into doors," he related. "It took six months to feel strong again, a year to get the bone mass back, and two years to get the details of my life together."

The question of astronaut health is of grave concern to Daniel Goldin, NASA's administrator, who said, "We don't even know if a broken bone will heal in space." To get answers, in 1997 Goldin established the National Space Biomedical Research Institute (NSBRI), a consortium of experts from a dozen leading universities and research institutes. NSBRI will study biomedical problems and by 2010 will present NASA with a "go" or "no go" recommendation on a Mars mission.

I began my investigation with Sutton, leader of the NSBRI smart medical systems team, who has treated the head trauma, wounds, kidney stones, and heart rhythm irregularities that one could encounter on the way to Mars. Even the common headache could raise the angst level in attending flight surgeons, says Sutton, because a plethora of possible causes includes emotional stress or an imminent catastrophic bleed in the brain.

I asked Sutton how he would cope with the toxic exposure that took place on Mir in June 1997. Floating through the Russian space station one evening, commander Vasily Tsibliyev suddenly confronted a basketball-size blob of antifreeze leaked from cooling pipes.

"There was nothing Tsibliyev could do," writer Bryan Burrough relates in his book *Dragonfly*. "He hit the giant drop head-on. Its oily edges slathered his face and hair in a noxious embrace . . . he hung there . . . clawing at his face. 'Sasha! Please, the towel!'" he pleaded. Tsibliyev wiped off the mess. After several days of nausea he recovered and today prospers as head of cosmonaut training.

On the spacecraft Sutton envisions, Mars-bound in the year, say, 2018, there may lurk another glob of antifreeze or perhaps harmful bacteria or carbon monoxide. No problem. The deadly substances will be detected by smart sensors—microprocessors no bigger than a thumbnail—that roam autonomously through the spacecraft, communicating their finds to a computer that warns the crew.

To cope with infection, Sutton plans a factory to make drugs, even new ones, to cope with possible organisms on Mars. Miniaturized optical and ultrasound devices will image body and brain—perhaps pinpointing the cause of a headache—while a small x-ray machine keeps track of any bone loss. Smart sensors embedded in clothing will monitor an astronaut's vital functions. The crew will be able to craft body parts, Sutton says, precisely tooled to an astronaut's personal anatomy and genome stored in computer memory.

Excuse me, body parts?

Yes, says Sutton, researchers are building artificial liver, bone, and cartilage tissue right now. "Let's take two worst cases: An astronaut bangs into a piece of equipment and suffers a subdural hematoma, a blood clot on the brain,

[COMFORT]
A bit of home as well as nourishment, dwarf wheat on Mir draws a warm look from Shannon Lucid, *who holds* the U.S. record for endurance in space. A Mars-bound crew might grow lettuce, tomatoes, onions, wheat, and other food, while recycling air, water, and solid waste.

NASA

and also severs part of an ear. On Earth that's a helicopter flight to special treatment at a trauma center."

In sick bay on Sutton's spacecraft, an astronaut not necessarily a doctor will wield the optical imaging system to locate the clot with a laser, then dissipate it with a tightly focused beam. To deal with the ear, he consults a three dimensional computer model of the injured person's body. The computer teaches him how to build a polymer model of the ear, then to grow new cartilage containing the astronaut's DNA. The computer guides him in seating the new ear part. "You just align part A with part B," says Sutton. "Then an ultrasound pulse heats and seals the wound."

The same ultrasound could be used to treat a ruptured artery. "You locate the bleeding by ultrasound," says Sutton, "then focus the same sound waves to heat the beam and cauterize the bleeding. That's completely noninvasive vascular surgery."

While Sutton prepares for the future, the question of bone loss pervades the present. It became an issue when two Skylab astronauts returned to Earth after long flights in the early 1970s, both with a bone deficit in their heels of 7 percent. Scientists suspect that the process begins with the atrophy of large weight-bearing muscles. The weakened muscles exert less torsion and compression on bones, which initiates a little understood process that drastically reduces bone renewal.

The obvious countermeasure seems to be exercise to keep the muscles fit, a course that has been pursued for many years. At the Institute for Biomedical Problems in Moscow, Inessa Kozlovskaya, a physiologist who has worked with cosmonauts for 25 years, details an exercise regimen developed in the early 1970s: a four-day cycle of bungee stretching and sessions on bicycles and treadmills.

The message according to Kozlovskaya is clear: Do the exercises, and you will be all right. Don't, and we will carry you off the spacecraft. "But it is up to them," she says. "I'm not a policeman." She tells me of Yuri V. Romanenko, a conscientious exerciser who landed after 329 days aboard Mir. Later nagged by reporters, he performed a one-arm handstand.

Kozlovskaya gave high marks to astronaut Shannon Lucid. "Shannon was not athletic, and she was not a young lady"—Lucid was 53 at the time. "I'm sure the exercise was torture for her, but she persisted. When everybody was going to lunch, Shannon was on the treadmill. In flight she was excellent in everything and was in good shape when she landed."

The undisputed star of the Russian program is Valery Polyakov, assistant director of the institute. When presented with a November 1996 issue of NATIONAL GEOGRAPHIC featuring pictures of Earth taken from space, Polyakov called out locations without bothering to look at captions. And no wonder. He's been in space longer than anyone, logging more than 14 months on Mir in 1994-95 and 8 months on an earlier flight.

Polyakov told me he spent two hours in intensive exercise every day, sweating a liter and a half. "My goal was to demonstrate the ability to work on Mars and come back in good health," he said, adding that he walked from the spacecraft under his own power.

Though Americans are impressed with the benefits of the Russian program, they bring up the nagging question of bone loss. "No one has returned from long-duration flight without bone loss," says Adrian D. LeBlanc, a professor at Baylor College of Medicine. LeBlanc explains that on Earth our bones are constantly renewed: Old bone is absorbed, new bone is formed. In space there is almost no renewal. "It's like a million Pac-Men chomping away," he said. "People have lost as much as 20 percent bone density in the hip."

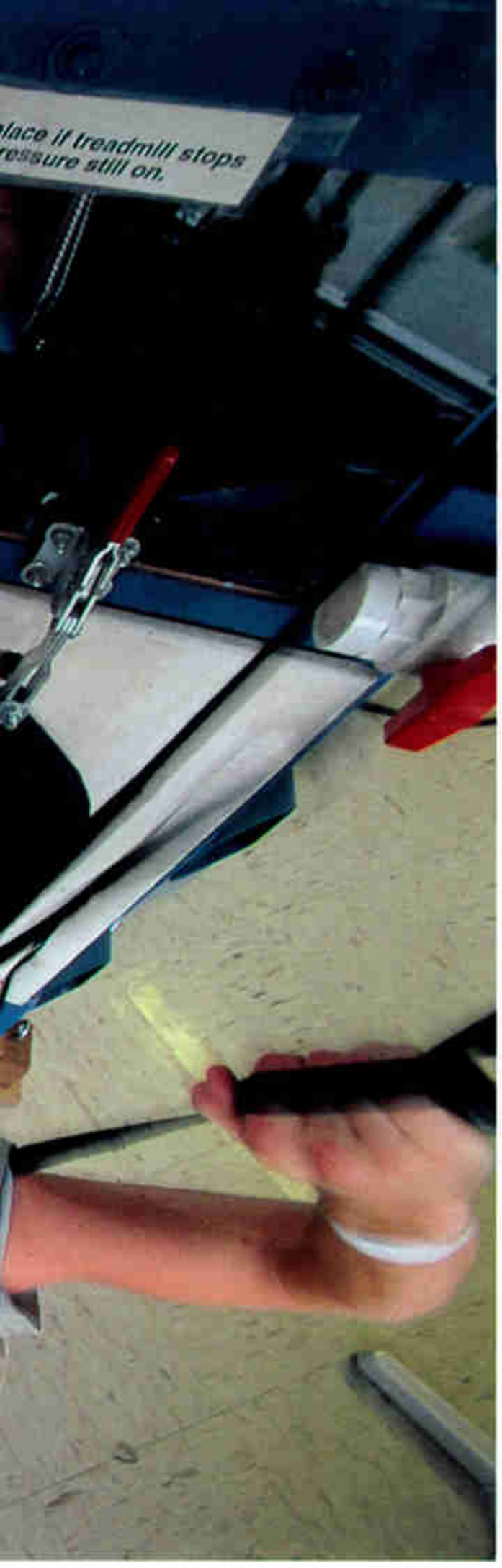
How long does it take to replace the lost bone mass? The process varies widely among individuals. Two of the American Mir astronauts who were in space longer than four months still have bone deficits more than two years after their return. The other five astronauts recovered their bone within six months to three years.

Scientists believe that bone loss during long spaceflights would level off after a while, pointing to paraplegics whose bone loss stops at around 40 percent, but this is unknown.

Researchers must find a way to stop bone loss before a Mars mission, says Jay R. Shapiro, a professor of endocrinology at the Uniformed Services University in Bethesda, Maryland, who is head of the NSBRI bone-loss team. "You better have 100 percent of your bone and muscle when you land on Mars," he says. "If you can't protect yourself on the way up, the risk of fracture is a very big deal."

One idea envisions giving astronauts drugs used on Earth to prevent osteoporosis. Another is an artificial gravity device that would provide doses of gravity to counteract the effects of weightlessness.

One day at the Man Vehicle Laboratory at MIT, I viewed a contender, a bedlike contraption that rotates at 23 rpm to produce 1 g on the occupant's feet. A researcher invited me



[GO DIRECTLY TO JAIL] Or something very like it passes the time for sets of identical twins (above) confined to bed for 30 days in artificial-gravity exercise tests at the University of California at San Diego. Bart Bradley gets a workout on a treadmill housed in a pressure chamber (left). In space this equipment would mimic gravity by raising blood pressure in his lower body. Research seeks to determine if Bart maintains his physical fitness compared with his reclining twin, Bret, whose workout amounts to a yawn.

to take a ride, which, he promised, would be "provocative."

"Turn your head 90 degrees to the right," he suggested. Though I have experienced the gyrations of air-combat maneuvering in such fighters as the F-15, I was stunned by a sudden, dizzying visual illusion—a pull-up followed by a roll to the right.

"Now turn your head to the left," I was told. An immediate and violent pitch down was accompanied by a roll to the left. Provocative, indeed, and to many people sick-making. Tests conducted after my visit showed that the illusions decrease with time, and the short-radius centrifuge remains a candidate to give astronauts a gravity fix, says Laurence R. Young, principal investigator and NSBRI director.

Earthlings who enjoy the sun's benign warmth may find its radiation tantrums difficult to believe. Coronal mass ejections fling billions of tons of electrically charged gas into space, relegating Earth's volcanic outbursts to mere hiccups. Colliding with Earth's magnetic field in March 1989, one such pulse shorted out a power grid in Quebec—like a power surge from a lightning strike—leaving six million Canadians murmuring in the dark. Solar flares explode on the sun's surface with the force of a hundred million Hiroshima bombs, launching protons toward any spacecraft in the neighborhood.

Nevertheless, NASA officials are confident that accurate monitoring will warn astronauts of such events, sending the crew scurrying into the space equivalent of a storm cellar, where polyethylene shielding will absorb the radiation.

A second kind of radiation, cosmic rays from the Milky Way or other galaxies, is a more serious threat—possessing too much energy, too much speed for shielding to be effective. Heavy ions such as iron forged in supernovae can travel up to a fantastic 185,000 miles a second, nearly the speed of light. "There's no way you can avoid them," says Francis Cucinotta, manager of space-radiation health research at NASA's Johnson Space Center. "They pass through tissue, walloping cells and leaving them unstable, mutated, or dead. Understanding their biological effects is a priority."

In one experiment researchers beamed

Seat-of-the-pants flying is replaced by a buzz on the torso. Lighted here in red, vibrators keyed to the position instruments tell the inventor, U.S. Navy Capt. Angus Rupert, that he's inverted. The vest could help astronauts orient during extravehicular activity.

nonlethal doses of heavy iron particles into the brains of rats. A significant reduction in the release of the brain chemical dopamine resulted—a factor in motor ability, cognition, and memory, all of which were impaired in the rats. Remarkably, when fed a diet that included blueberry extract rich in antioxidants, the rats seemed to improve.

Other researchers have found that tamoxifen, an anticancer drug effective in humans, reduces the number of tumors in rats irradiated with the same heavy iron particles.

Another major concern is the psychological health of astronauts, despite their right-stuff exploits cooly performed in the face of danger and stress. Michael Collins cruises the dark side of the moon in 1969 out of radio contact with Earth—a situation that would set my hairs on end—and reports "almost exultation." After an explosion aboard moon-bound Apollo 13 in 1970, commander James Lovell, Jr., calmly tells Houston that there is a "problem" and proceeds, with his crew and help from Earth, to patch things up and return safely. My favorite: astronauts who nap on the launch pad while waiting for the rocket to fire.

But there's a new stressor on a three-year Mars mission—people, other members of the crew. "The problem is," says Mir astronaut Andrew Thomas, "they're always the same people."

To observe how the same people get along

[WHICH WAY IS UP?]

A virtual room seen through a headset at MIT challenges a real person's sense of location. Symbols serve as orienting cues as the person moves. Researchers hope to adapt the technique to help astronauts maneuver in large spacecraft. Operating in complex passageways and modules without gravity cues, they share a predicament—which way to go?

CARY WOLINSKY WITH COMPUTER ENHANCEMENT BY BRIAN STRAUSS, NGS STAFF (RIGHT)

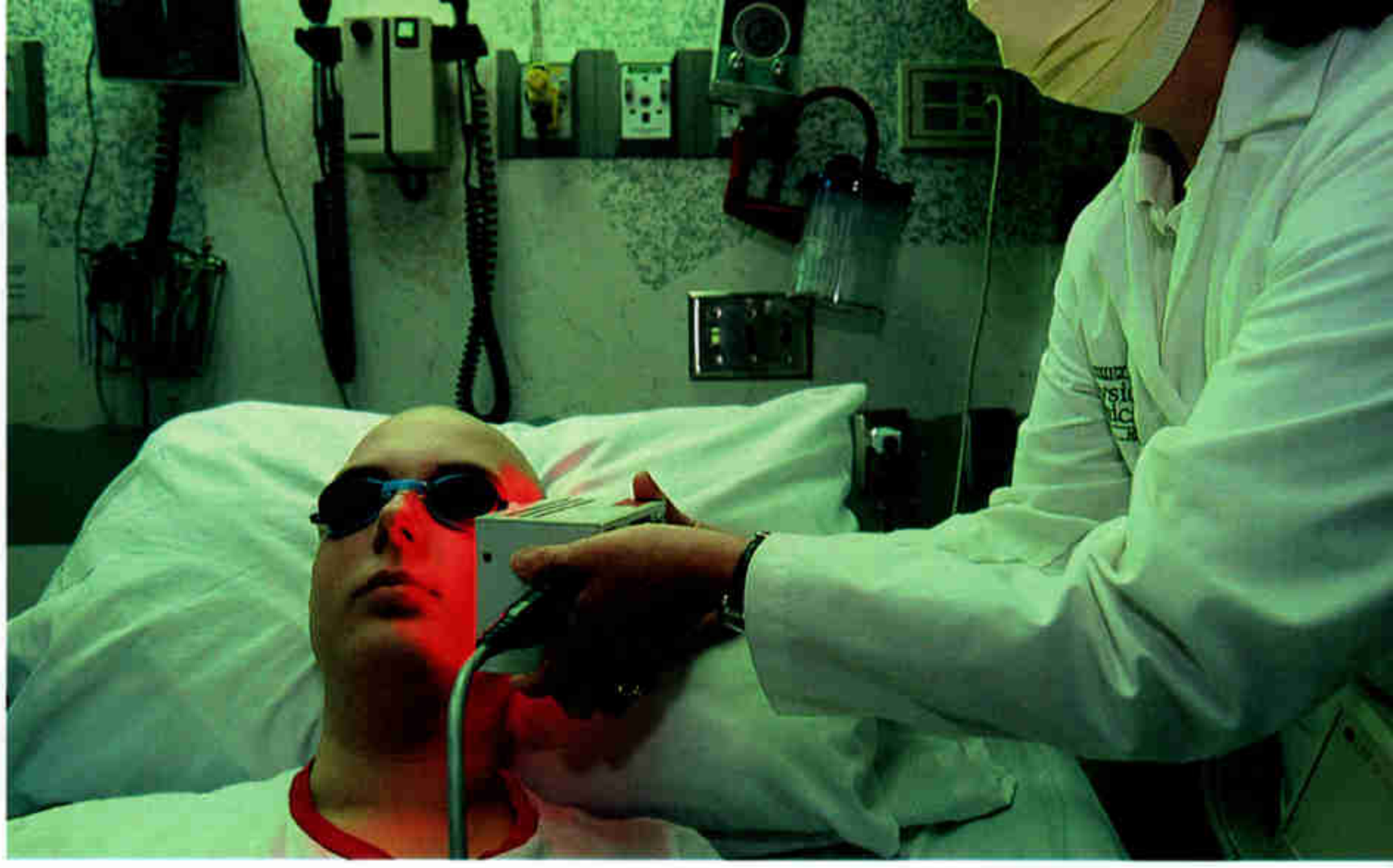
over time, the Russians have confined volunteers for as long as eight months, with mixed results. "All hell can break loose in there," says an observer. Last year during one such confinement two Russians brawled on New Year's Eve, a Canadian woman claimed she was forcibly kissed by one of the Russians, and a Japanese volunteer asked to leave the experiment because of the commotion.

NASA found that the stresses of isolation and confinement can be brought on rapidly, simply by giving people few tasks. Astronaut Thomas described how six astronauts were confined in a 12-foot-square room for a week. "If you give them little to do, stress can be achieved in a couple of days," says Thomas. "Some astronauts treat this as a piece of cake, but it can be extremely difficult." The goal is for astronauts to manage themselves, to pull together, to structure time so that everyone meets his personal needs. "The response has been very positive," says Thomas.

NASA had already learned that too much supervision can be a problem as well. Every day on a Skylab mission that ended in 1974, mission control sent the three astronauts a six-foot-long sheet of instructions. "Our system was designed to squeeze every minute out of an astronaut's day," said the lead flight director. The ground even began scheduling experiments during the crew's mealtimes.

Finally, the astronauts rebelled. In a stinging rebuke to the ground, commander Gerald P. Carr announced that the crew was on strike. They were going to relax and do as they pleased. They were going to look out the window, take pictures they wanted to take. Stunned controllers got the message and finally concluded that astronaut time off was "mandatory" and "inviolate."

Cultural differences pose significant challenges for a Mars crew that will likely be



[LIGHT THAT HEALS] Weakened by chemotherapy in his fight against Hodgkin's disease, Eric Tydd (above) gets a 91-second dose of near-infrared light from light-emitting diodes (LEDs) at the children's hospital in Milwaukee, Wisconsin. The light penetrates tissue to energize cells and prevent the growth of chemo-induced mouth sores that keep patients from eating. Waving the magic LEDs (left), neurologist Harry T. Whelan has successfully treated wounds, third-degree burns, and brain cancer on Earth and thinks the same can be done in space.

multinational. Aboard Mir, astronaut David Wolf had problems with the two Russian cosmonauts. "Where Americans say 'please,' Russians tend to bark orders," he said. "So you feel like you're being yelled at. At mealtimes, they go after the best food. I felt like they were stealing the best food. After a while I asked, 'Why are you doing this?'

"They were surprised. They told me, 'David, you need to jump in. We wondered why you weren't jumping in.' So I started to jump in, and everything was fine." Wolf concluded: "When you understand these cultural differences, they don't make any difference anymore. But they do make a difference until you understand them."

Christopher F. Flynn, a NASA psychiatrist and flight surgeon, worries about the mental health of astronauts, including depression. "Even in healthy people the risk of depression remains high through the fifth decade of life," he says. "How can we tell whether an astronaut is depressed or suffering from isolation? At the moment, I'm stumped."

So is everyone else. David Dinges, head of the NSBRI neurobehavioral team and a psychologist at the University of Pennsylvania, searches for a quantitative means of recognizing stress, mood, and perhaps depression: "We can't rely on anecdote, what people are saying on the way to Mars. We need a measure of behavior."

Dinges and Dimitris Metaxas, a professor of computer science at the university, aim to build a computer program that can recognize emotional states. Already Metaxas has shown that a computer can recognize sign language. "The task ahead," says Dinges, "is to train the computer to recognize facial expressions associated with human emotion, the slanted eyebrows of sadness, the wide eyes of surprise." The computer's imaging system records information in tiny pixels, which enables it to determine subtle changes in expression.

How might astronauts react to such monitoring? "I think we'd have trouble trusting it," Andrew Thomas said. "And I think many of us would consider such a computer invasive."

Dinges counters: "Clearly astronauts have a right to privacy. At the same time the public is paying to learn how we're going to get humans into space safely. We need to balance these two

things." Don't expect this issue to go away any time soon.

Will NSBRI meet Daniel Goldin's 2010 deadline for a decision on Mars? "Yes, we will, perhaps even before. We're very confident," says Laurence Young, the director of NSBRI. Young, who was a backup payload specialist on a 1993 shuttle mission, looks fit enough to fly tomorrow.

Meanwhile, some of NSBRI's research may bear fruit on Earth. The institute has made one discovery that promises to save many people at risk of sudden cardiac death, usually brought on by a heart-rhythm disturbance called ventricular fibrillation. This kills 225,000 people in the U.S. each year.

Richard Cohen, a cardiologist at MIT and head of the NSBRI cardiovascular team, explained that zero gravity may—emphasizing "may"—incite this condition in astronauts. So the team invented a noninvasive diagnostic device that measures extremely tiny changes in heart rhythm on the order of a millionth of a volt.

The team found that the device can be used as part of a standard stress test to identify patients at risk. Then pacemaker-like devices can be implanted to regulate the rhythm anomalies. "This technology has the potential to save hundreds of thousands

PHOTO COMPOSITE: SOLAR PROMINENCES, NASA; CARY WOLINSKY

[SANCTUARY FROM RADIATION]

The sun occasionally lets loose billions of tons of protons and helium nuclei in an outburst called a coronal mass ejection. The blasts have fried the electronics of satellites and present a lethal threat to astronauts by depleting bone marrow and killing cells in vital organs. Polyethylene helps protect sailors on nuclear submarines. Can it do the same in space?

of lives," says Cohen. "NASA can be proud."

Such discoveries are no accident, says Michael E. DeBakey, a board member of NSBRI and a cardiovascular surgeon who has saved many hearts himself. After returning from Russia—a nine-hour time change—DeBakey, 91, worked all day at Baylor. At 6:15 p.m. the corridors were deserted when he sat down with me, attired in a blue surgeon's smock.

The key word is research, DeBakey said. "When I was a medical student, and a patient came to the hospital with a heart attack, things were mostly up to God. Today there's a better than 95 percent chance to survive. Now that all comes from research.

"The unfortunate thing is that there are people, even some scientists, who look at the money that goes to NASA and say, you know, we could use that money to support our work. That's very shortsighted. The more research that's done in any area of science, the better off everyone is going to be. The more that's done in physics, the better off I am in cardiology. There's no better investment for a society than research." □

MORE ON OUR WEBSITE

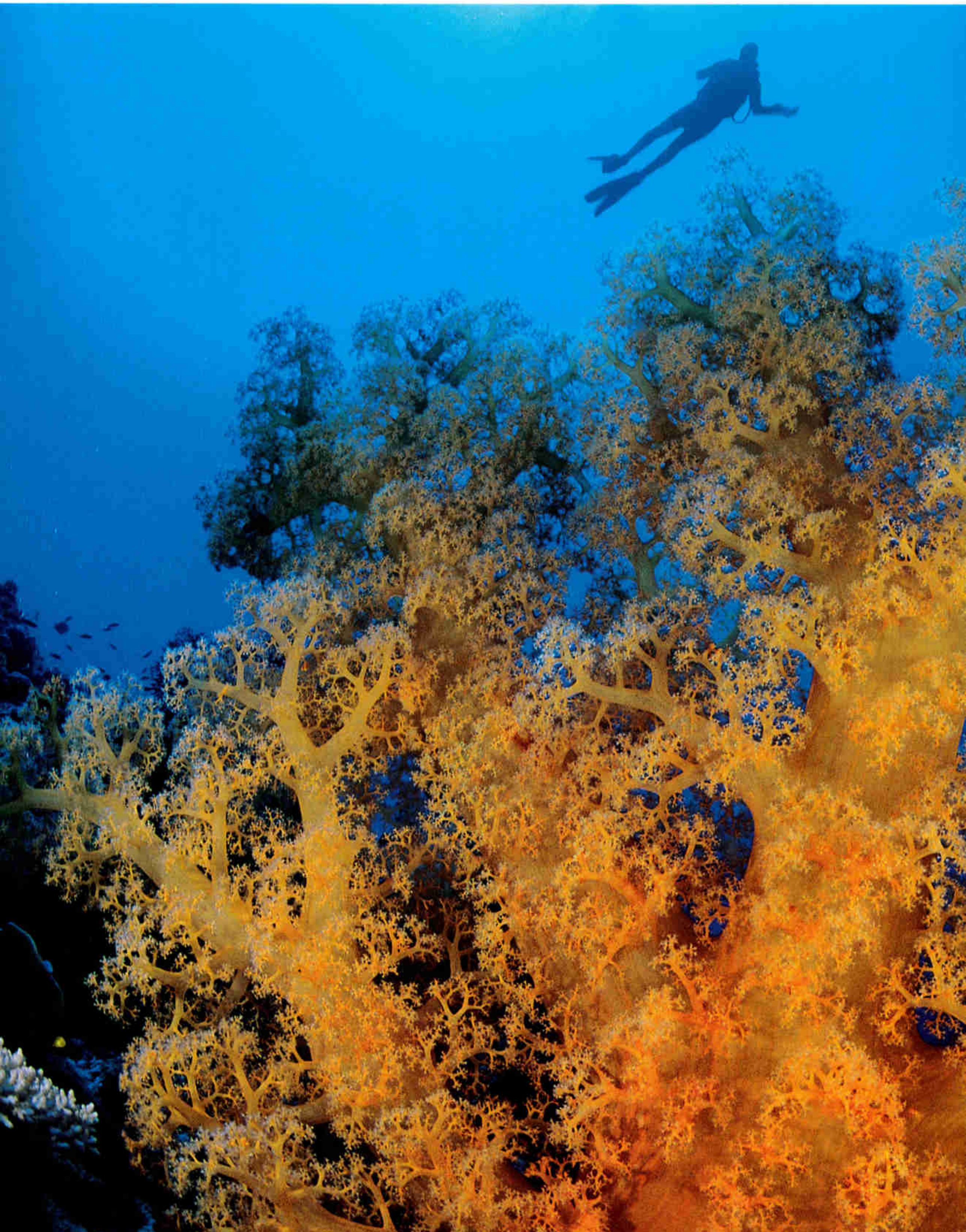
Do humans belong in space or should society place its resources elsewhere? Join our forum at **nationalgeographic.com/ngm/0101**.

KINGDOM

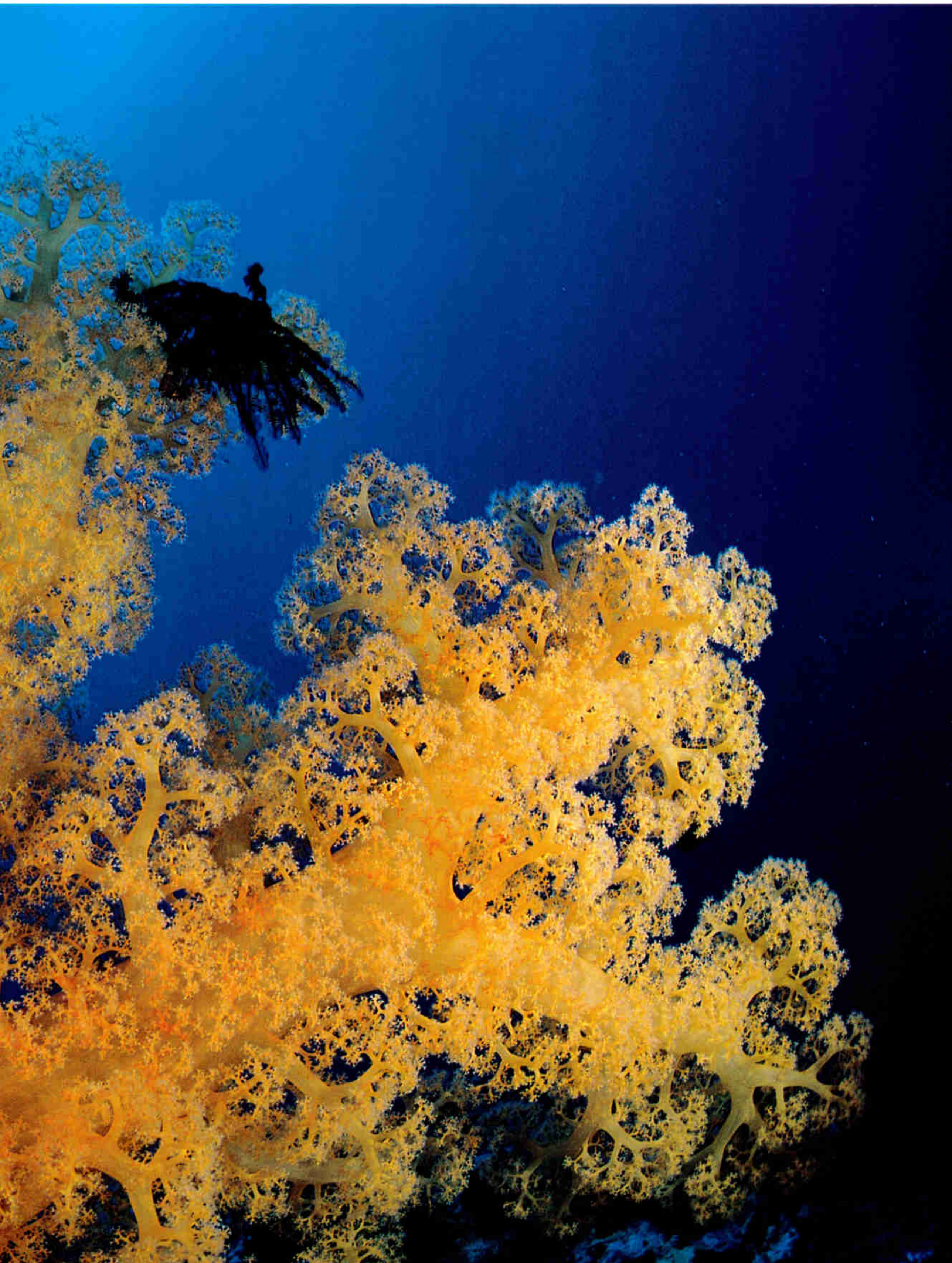
OF CORAL

AT BARRIER REEF

SERVING UP A FEAST *of natural wonders—including broccoli coral—the Great Barrier Reef*



stretches for more than 1,250 miles in a graceful crescent along Australia's northeast coast.



A SWEETLIPS BY NAME *gets sweet lips by nature as a cleaner wrasse picks parasites off its host's skin*

By **DOUGLAS H. CHADWICK**

Photographs by **DAVID DOUBILET**

SOMETIMES AT ITS OUTER EDGE and sometimes closer, the beam from the flashlight kept reflecting off big cat eyes. They glimmered pale silver, with pupils darker than the darkness through which they glided. But cats don't patrol 40 feet deep in the Coral Sea. These were sharks. It was hard to tell what kind they were, but some of the shadowy bodies looked a lot longer than mine.

I breathed up my scuba tank's air sooner than planned and had to surface far from the boat. Then I was swimming through black swells toward the ship's distant light as though mired in one of those dreams where you need to move faster but can't. I promised myself that it would be a while before my next night dive on Australia's Great Barrier Reef. Yet within days I was beneath a full moon and 50 feet of water looking at more cat eyes.

These belonged to an epaulette shark, small and lovely and speckled, lithe as an eel as it curled round a coral pillar. Two lionfish with fins like flared wing feathers cruised upside down beneath a coral table as though that were the seafloor. Above them a pinnacle of coral twisted nearly to the surface, lit from

and mouth. The fish, schooling below, welcome such grooming, which helps prevent infection and disease.

SMALL BUT FEISTY, *a golden damsel (above) will grow no longer than five inches but is territorial and defends its domain against all trespassers, no matter their size. Even smaller than*

behind by the ship's lamps and the moon.

Silhouetted, each shelf, frond, curlicue, and fan emphasized the eerie configurations that develop in the near absence of gravity. Drifting weightless beside them seemed like sightseeing on another planet. But the moment I thought that, I realized that I had it wrong. This scene was the very essence of our home planet, which is, after all, ocean blue. A single coral wall holds a broader representation of earthly life—species from more phyla, or major groups—than an entire continent does. It seems otherworldly only to those of us born above tide line.

Coral reefs form when colonies of tropical marine plants and animals with limestone skeletons rise atop earlier generations. They fashion the most visually diverse natural environments a human can experience, and the Great Barrier Reef is the world's single largest coral domain. With the broad, shallow continental shelf of tropical northeastern Australia providing an ideal pedestal for growth, this coral complex reaches as far as 160 miles offshore and more than 1,250 miles from north to south. The Great Barrier Reef covers 135,000 square miles, an expanse greater than Poland.

To explore what amounts to an offshore nation, photographer David Doubilet and I roamed 4,000 miles on dive boats. We spent so many hours submerged that I began to think land looked weird. The day I found the same sort of remora fish that clings to sharks and manta rays hitching a ride on my leg, I wondered if it might not be time to dry out.

Although the name suggests a continuous strip, the Great Barrier Reef is actually a commonwealth of at least 2,800 reefs. Only some are true barrier reefs—breakwaters rising near the edge of the continental shelf. In the calmer seas behind that cordon, more reefs appear as irregular circles and crescents known as platform reefs. Smaller formations, called patch reefs, are scattered throughout shallow areas.

Fringing reefs grow outward from the mainland's shores, but more often they are found surrounding the region's 618

continental, or high, islands, which were mountains and hills along Australia's Ice Age coast before the glaciers melted and raised sea levels; the Aborigines' legends of ancient generations walking out to those islands are true. In addition there are about 300 low islands, or cays, formed atop coral shoals from reef sediments. As seabird droppings glue the grains together and colonizing plants build soil, some of those desert isles transform into shadowy woodlands, while storms pound others back into shifting piles of sand.

By acting as a buffer against heavy seas, the reef-and-island complex makes possible neighboring sea grass beds and coastal mangrove forests. Those in turn trap sediments, store nutrients, and serve as nurseries for a number of reef residents. Now add the soft sea bottoms between reefs plus submarine hillocks made entirely of *Halimeda*, a calcium-hardened green algae.

Put all these habitats together with clear azure waters flowing from the Coral Sea and brown, soil-laden waters washing off the continent. Mix with currents, daily tides, and seasonal weather patterns. What you have is the formula for the Great Barrier Reef ecosystem and lifetimes of discovery.

THE BETTER we came to know this offshore nation, the more it resembled a long chain of provinces. Four major sections are widely recognized: Mackay/Capricorn in the south, where the water first warms enough to encourage coral growth, Central, Cairns, and Far Northern, which is the most remote and, being closest to the Equator, hosts the lushest array of life.

Our first destination was the Eastern Fields, a rarely visited atoll that lies outside the Far Northern section near the Gulf of Papua, 200 miles east of Australia's Cape York Peninsula

the damsel, whip gobies (below)—less than two inches long—stick close to the thin, polyp-studded coral sea whips that serve as home, feeding ground, and nesting place.

"SHARKS WERE EVERYWHERE *along the reef," says photographer David Doubilet. "We ran into*

plenty of whitetips like this pair, but they tended to be curious, not at all aggressive."

and approaching New Guinea. This pristine marine wilderness represents a part of the Pacific that seeded the continental shelf with coral some 20 million years ago, after Australia drifted north into the tropics.

While I strapped on an air tank, Duncan Johnstone, one of the professional divers helping to crew our boat, offered advice. The waters, he said, would be very clear, with visibility at 150 feet or more, and very shacky, "shack" being how Aussies say "shark." What kind? "Whalers," another name for members of the requiem shark family. Great whites are rare in tropical waters. Another big boy is not: the tiger shark, a whaler that grows to 20 feet. But Johnstone was referring to the more common five- to ten-foot-long bronze whalers, gray reef sharks, and silvertips.

"They hunt in small packs," he continued. "and they like to come right up for a look, give you a bit of a squeeze. Just back toward the reef if you can. *Don't* go popping to the surface."

Descending past green coral that looked like sunken organ pipes, I got squeezed by a pack right away. The whalers moved on, and I leveled out a hundred feet down on the lip of a sheer drop. I hovered awhile, then kicked out into nothing but blueness. Though my depth gauge gave a constant reading, I couldn't shake the perception of falling. Southern bluefin tuna cruised under my feet. Schooling unicornfish and trevallies, or jacks, swirled past like currents made visible. Far bigger shapes bulked where the blue turned to gloom.

Feeling more and more like a hapless mote of plankton, I turned back and drifted up balcony-like tiers of coral toward the clerestory light far above through chromis, sergeants, triggerfish, surgeonfish, and clouds of other fish feeding on everything from algae to shrimps to the corals that housed them. By the time I neared the anchor line, I knew the main challenge ahead wasn't going to be sharks. It was going to be how to make sense of the polychrome dazzle of creation that is a reef.

Heaving aboard after a dive, I would head straight for the identification books, thinking: Surely I can pick out the rainbow fish with pink stripes radiating from its eyes. Aha, it's a wrasse. But there must be a hundred wrasses here—and at least a dozen with that eye pattern. So is it the tailspot, threespot, checkerboard, pinkbelly, moon, or sunset wrasse?

With new fish species found in the Great Barrier area every year, the total is approaching 2,000. It will likely keep rising. So will the estimates of 4,000 mollusks and at least 350 hard, or reef-building, corals. Researchers counted more than 250 types of shrimps on the reefs just around Heron Island, near the Great Barrier's southern end. One volleyball-size coral chunk there yielded 1,441 worms from 103 species.

Perhaps for want of enough names to go around, many of the fish I swam with had labels borrowed from land animals: lizardfish, batfish, hogfish, and that double steal, the foxface rabbitfish. Getting better at recognizing species only made me more curious to know why there were so many kinds in the first place. What drives this extravagance of color and form? And how is such biological wealth even possible when the clear, blue quality of tropical seas reflects a scarcity of nutrients and plankton, the base of the food pyramid?

THE NORTHERN REEFS form a nearly continuous ribbon for about 400 miles. Near the Olinda Entrance, a narrow break in the bulwark, I kayaked across the wave-beaten reef flat behind a coral slope, then dropped overboard with snorkel gear. Dark shapes shot across the bottom ten feet below. I tried to follow before I realized that the water was so transparent that I was chasing the shadows of brown boobies flying overhead, carrying fish to the fluffy white chicks waiting on a nearby cay. When I looked down again, I noticed some seaweed tumbling in the current. Then the lacy brown clump hung a left, circled a piece of coral rubble, and darted after a speck of food.

Pretty good for algae, or rather for a juvenile rockmover wrasse that looks and acts like drifting debris, right down to rolling from side to side, presumably to fool predators. Another juvenile has the same flip-flop swimming style, and one is thought to mimic a foul-tasting flatworm for the same purpose. The fact that the adult fish may have different patterns of

POPPING UP *like a carnival whack-a-mole, a blenny has a close encounter with a nudibranch, a mollusk notable for its lack of a shell. For protection a nudibranch relies instead upon its bright colors and speckled skin, which warn predators: Don't eat me. I taste terrible.*

fins, color, and behavior was my first clue to the puzzle of the diversity around me.

Near the Portlock Reefs I couldn't figure out the dots moving behind a crack in a coral ridge. My diving partner did, seeing the toothy end of a six-foot-long black-spotted moray eel emerge to inspect my head from behind. By then I was distracted by a gold-and-white juvenile bicolor parrotfish. As adults, females are reddish brown and males are jade-and-pink. Thus the animal comes in three distinct models. Other fish produce half a dozen—a stronger clue as to how scores of species around a coral knoll can look like hundreds.

A broad spectrum of reef fish switch sex as they age or as changes in the social environment trigger hormones that promote male characteristics at the expense of female traits or vice versa. When the male fairy basslet attending a harem disappears, the dominant female may start acting like a male within hours and become one physically within a few days.

Temporary color changes add to the complexities of sorting out who's who on the Great Barrier. I watched a brown trumpetfish swim behind a slow-moving star puffer and match its gray tones while using the big blowfish for concealment to sneak up on prey.

I lay on the deck and was just dozing off when it came to me. Not enlightenment, but another fish—splat on my eye. No trouble identifying this one: a flying fish that was soaring away from a pursuer on long, winglike pectoral fins. Tiny squid and baitfish were always jetting onto the stern steps. When Johnstone was filleting a coral trout there for dinner, a bronze whaler surged up onto the transom and thrashed around, trying its damnedest to help carve the meat. Boobies, noddies, and terns perched and pooped all over the bow. We seemed to be joining the ecosystem. No other boat had come into sight for hundreds of miles. Perfect. Just us and the sea.

Part of the pleasure of these unspoiled surroundings came from knowing that Australia was managing them to stay that way. In 1975 virtually the whole offshore nation was declared Great Barrier Reef Marine Park, one of the world's first national marine sanctuaries and still the biggest. Intended mainly to

LIQUID LABYRINTH: *The reef's countless nooks and niches promote enormous biodiversity.*

prevent oil drilling and mining on the reef, the park remains open to many other uses. Commercial fishing, sportfishing, spearfishing, and the collecting of aquarium fish and shells are regulated, however, and some segments are set aside as no-take zones, research zones, or special reserves for troubled species such as dugongs, marine mammals closely related to manatees.

Of the globe's seven species of sea turtles, six are found in the Great Barrier region. The least imperiled is the flatback, which keeps to Australian waters. Female green turtles travel 1,600 miles from places like Indonesia and New Caledonia to lay their eggs in spots such as Raine Island, a northern cay. From the boat we watched thousands transform the beach nightly with flailing flippers and flying sand, scattering the seabirds that also come to nest.

Many of the Great Barrier islands are overseen by the Queensland Parks and Wildlife Service, which does much of the day-to-day work of supervising the marine park as well. Raine Island, where Aborigines once came in outrigger canoes to gather food, is now off-limits to most visitors to protect the nesting wildlife, but we were free to swim along the coral slopes it rests upon.

Turtles would pass so close we could make out marks from shark teeth on their shells and chunks missing from limbs. More of the 200- to 400-pound reptiles rested until nightfall in caves on the reef wall. I never peered into one of those dark nooks without also seeing the big eyes of cardinalfish, squirrelfish, or other nocturnal species looking back—yet another clue to the area's extraordinary biological wealth.

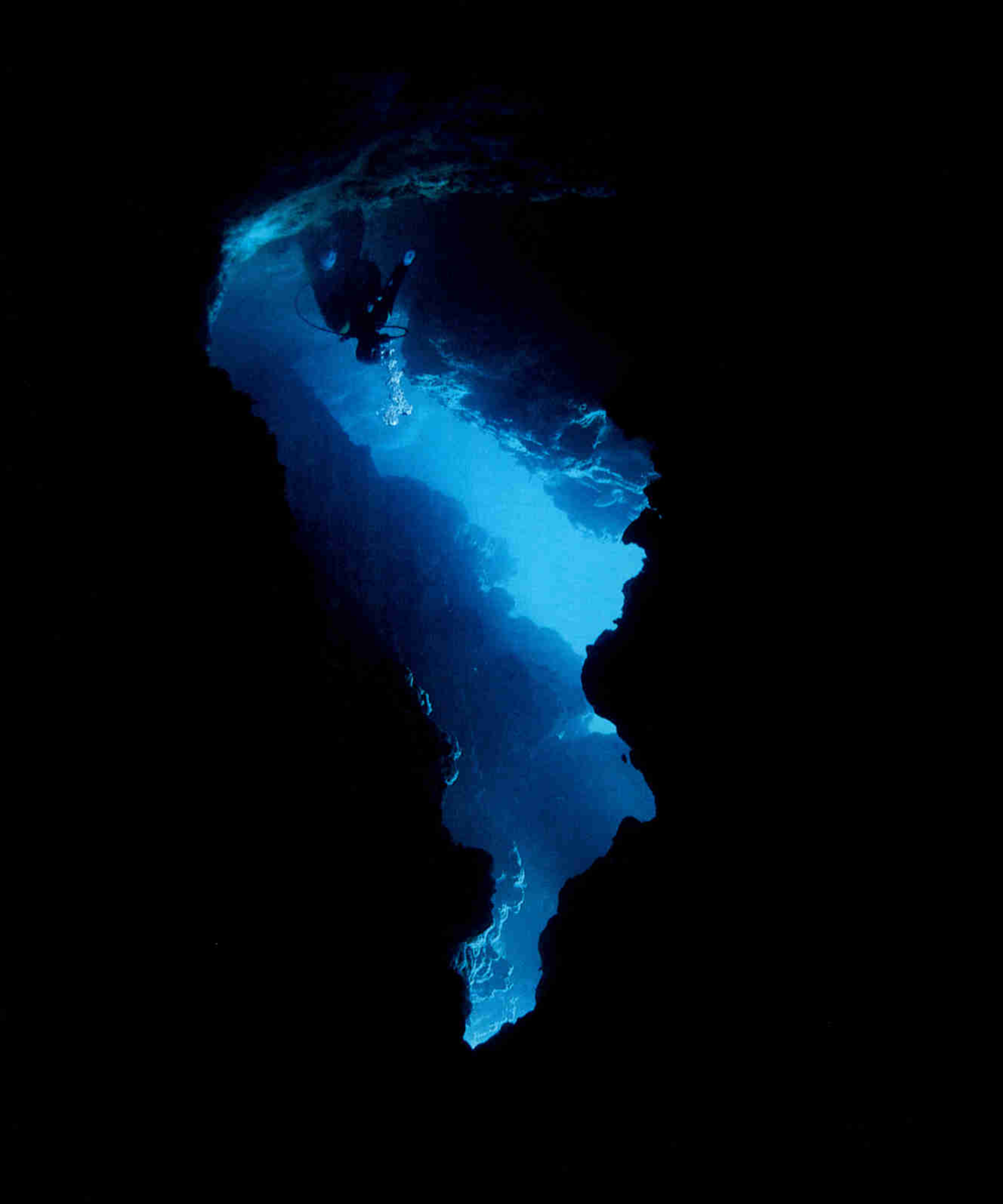
Coral reefs are riddled with caverns and crevices—a microtopography that greatly multiplies both the total surface area and the variety of niches available. This is where the night shift spends the day, the day shift hides at night, and an assortment of sea squirts, soft corals, and sponges, which lack rigid skeletons, makes a full-time home. Tighter crannies take the place of shells, spines, or foul-tasting chemicals as protection for other creatures. Many, including some algae and sponges that look too soft for the job, bore tunnels of their own.

CONTINUING SOUTHWARD through the Far Northern section, we finally drew near enough to land to see Cape Weymouth on the horizon, then reconnoitered underwater for hours by Ferguson Reef. I sank down to rest on a sand patch, discovered I was maybe a dozen feet from a whitetip reef shark doing the same thing, and finger-walked over to a wider sand slope. The shark never budged, but within a minute the barren-looking habitat had scores of garden eels growing out of it, emerging from burrows as the shock of my arrival wore off.

Bumphead parrotfish seemed awfully fond of the place as well. Largest of the region's 29 parrotfish species, a bumphead can weigh more than a hundred pounds and devour five tons of coral a year. After gouging out chunks with teeth fused into a beak, it chews them with a second set of powerful jaws deep in the throat. As the fish defecated, a curtain of coral slurry descended upon me, and I tried to keep in mind the fact that many a perfect coral sand beach comes from parrotfish dung.

Stay down long enough and even tropical seas drain your body heat. To warm up, all I had to do was rise toward the surface, stoked to bathtub temperature by the sun. When I floated over sand at this upper level, the brightness made my eyes ache. The driving force behind the abundance of reef life was becoming hard to miss: limitless solar power. Just as on land, the marine food chain rests upon the ability of plants to convert solar energy to food and building materials. The secret to the fecundity of the Great Barrier is that so many of the plants dwell inside animals.

Mistaken for colorful plants themselves at one time, corals are actually carnivores related to anemones and jellyfish. Like them, corals use tentacles with stinging cells to snare microscopic prey. Corals can also catch food on their mucous coating and absorb nutrients directly through their epidermis. Even so, as much as 90 percent of their nourishment comes from golden brown algae they host in their tissues at a density of millions per square inch. The corals' enzymes cause the algae to leak carbohydrates. In return the algae get nitrogen from



THE EMERALD PLATFORM *that surrounds the dark green sliver of Wreck Island is just one of roughly 2,800 separate reefs that constitute this huge maritime rampart—considered the world's largest coral reef system and the largest structure built by living organisms.*

the corals' waste material, along with a home.

About 90 percent of giant clams' food comes from the same symbiotic algae. The clams grow these microscopic plants beneath translucent panels, essentially farming them inside a fleshy greenhouse. A surprising number of other animals nurture internal algae too, from sponges to thin-skinned flatworms.

Partnerships play a role almost anywhere you look on a reef. The largest marine fish family is that of gobies, with more than 2,000 species worldwide. Many of the known tropical species share burrows with shrimps, which keep the holes clean while the gobies act as sentinels, warning of danger. Not that the laws of tooth and maw have been repealed. During one dive I saw a diagonal-banded sweetlips open wide to have parasites removed from its mouth and gills by what looked like a cleaner wrasse. Instead a fang-toothed blenny, an accomplished mimic of the cleaner wrasse, bit off a hunk of the sweetlips's inner cheek and skedaddled. Close by, a big barracuda yawned to accommodate a true cleaner wrasse—then snapped its teeth shut and gulped the thing.

Roughly 175 miles south of Ferguson Reef we crossed into the Cairns section, where the Great Barrier generally runs nearest the mainland, and stepped onto Lizard Island after three weeks at sea. The ground seemed to sway so much I could hardly stand. Still, the prospect of walking for more than the 72-foot length of our boat was so exhilarating that I staggered all the way to Cook's Look, the island's granite summit, 1,178 feet above sea level.

In 1770, during a voyage to find the rumored continent of Terra Australis, Capt. James Cook of England scrambled up to search for a way

out of what he had begun to view as an endless barricade of reefs. The great navigator had already holed the hull on the coral once. By 1900 the Great Barrier had claimed 1,200 vessels. We had made a few edgy excursions ourselves through portions still marked "Unsurveyed."

During my visit Cook's Look was wrapped in glowing clouds. Torresian imperial pigeons called from eucalyptus trees, and four-foot monitor lizards rustled in the leaves underneath. The place spoke less of the European era than of Dreamtime, the mystical age envisioned by Aborigines who once held initiation rites for young men atop the peak.

Hiking on to the Lizard Island Research Station, I tracked down Bob Podolsky, a marine biologist visiting from the University of North Carolina at Chapel Hill. He had come to study brittle stars, so named because their long arms break off easily. While a detached arm coils and squirms, distracting whatever grabbed it, the rest of the brittle star can escape, soon to regrow the missing limb.

Podolsky focused a microscope on a larva hatched from a minuscule brittle star egg. An eater of algae, this nearly invisible plankton particle looked nothing like the adult—or anything else, except maybe avant-garde jewelry or an interstellar probe. I was remembering why my first childhood glimpse of the animated cosmos within a water droplet hooked me on biology forever when Podolsky said, "An adult brittle star puts out more than a million larvae in its lifetime and yet will replace itself with just a single offspring if it's lucky. So the chance of a larva surviving is literally one in a million."

We often say life is miraculous. Here was a statistic to back that up. To reach maturity, each brittle star has to be the very fittest—and luckiest—of the fit. The same holds true for many other organisms in the coral realm, including corals themselves. Repeat such one-in-a-million success stories every generation over millions of years, and an amazing array of forms with spectacular adaptations becomes not just possible but probable.

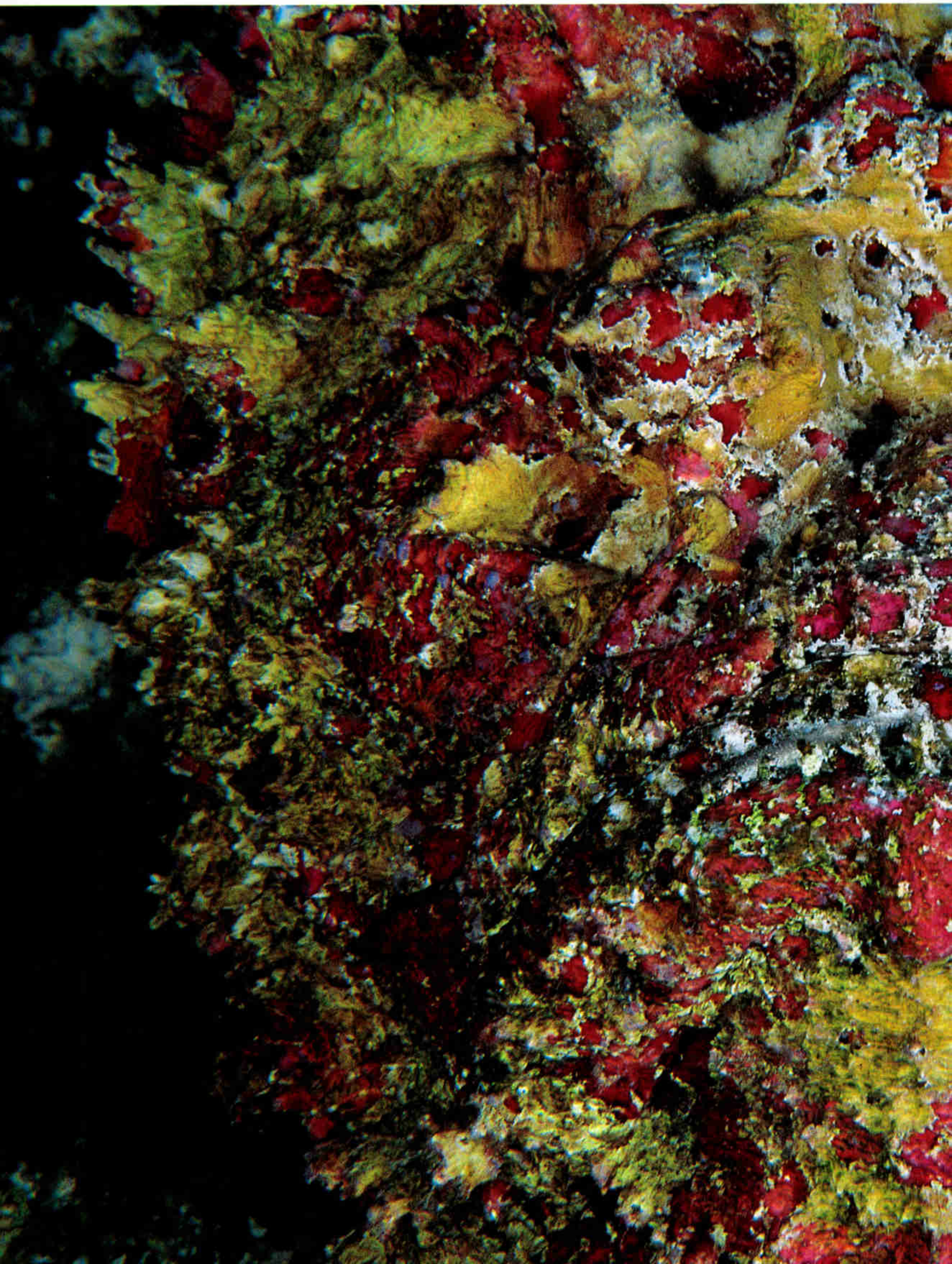
THREE DAYS LATER we jumped in on Hastings Reef. Within easy reach of the port city of Cairns, it turned into the busiest spot we had yet seen as arriving boats discharged divers and snorkelers. The locale had a worn look that came from a lot of flippered feet kicking the reef and hands grabbing for a closer look. But it was also under assault by crown-of-thorns, the huge, spiked, poison-tipped sea stars that dine on live coral.

As I hovered by pajama cardinalfish—think chubby minnows in clown outfits—a diver came by and thrust a long spear into one of the stars. Periodic outbreaks of crown-of-thorns can strip reefs of color and life. While scientists debate whether these are natural events, like wildfire, or the result of human activities, such as the overharvest of fish that eat juvenile crown-of-thorns, tour operators hire people to remove adult stars daily from popular sites.

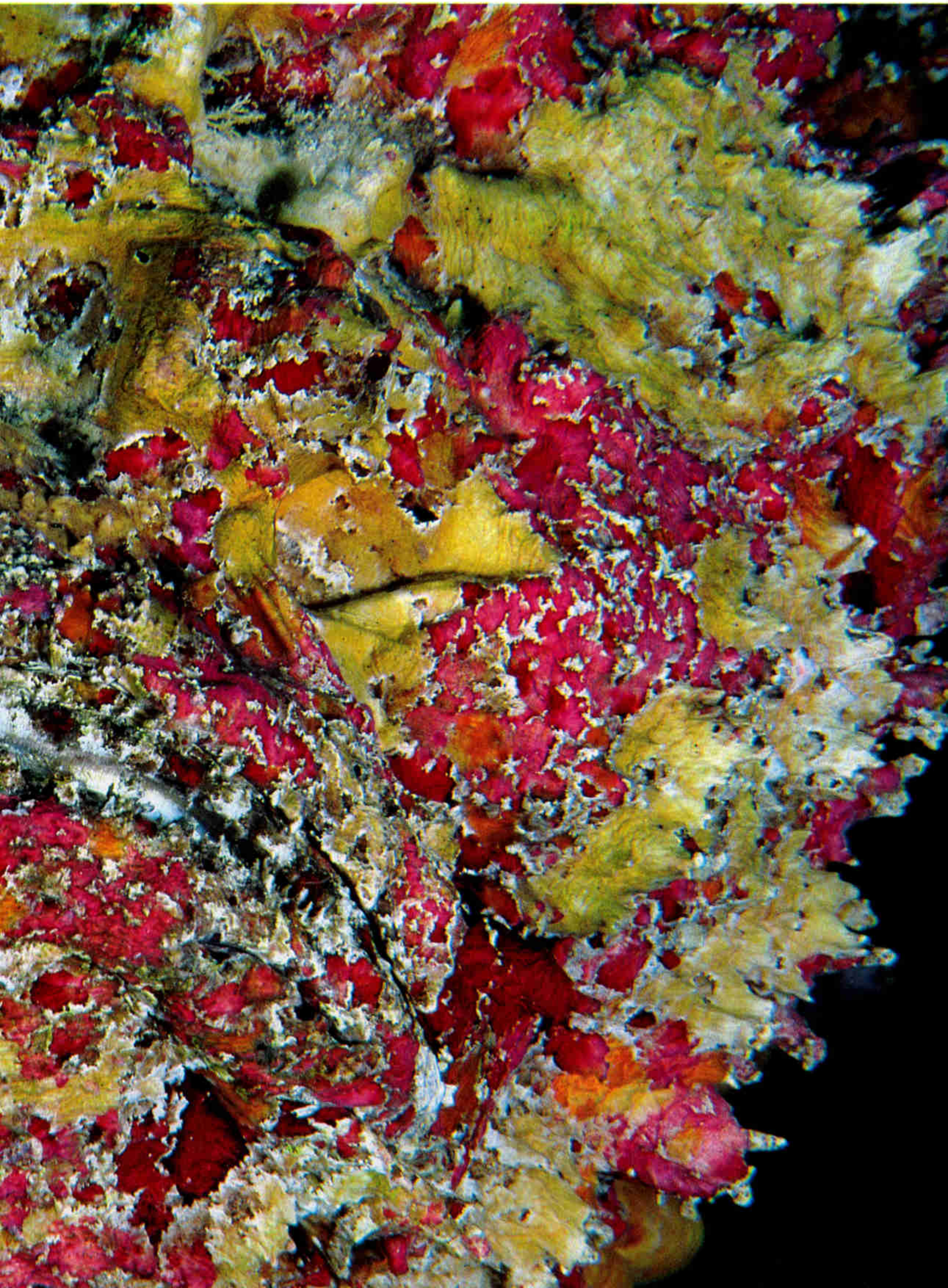
There are only 3.5 million residents in the entire state of Queensland, but the growing city of Cairns receives nearly 800,000 international visitors yearly. Most come for a look at the Great Barrier. That the sumptuous reefs in crystalline water shown on travel posters lie 25 miles or more offshore often comes as a surprise. Boarding one of the high-speed catamarans that carry as many as 300 passengers there at a time, I found crew members stationed up front with determined smiles and rubber gloves, ready to deal with seasickness bags.

Once we reached Agincourt Reefs, the craft docked at a huge, stable platform anchored by cables. Some groups headed out on guided diving or snorkeling tours. I opted for the ten-minute helicopter overview of the turquoise shoals. Afterward I sat beside a German grandmother to motor past coral walls in a glass-sided semisubmarine, *(Continued on page 50)*

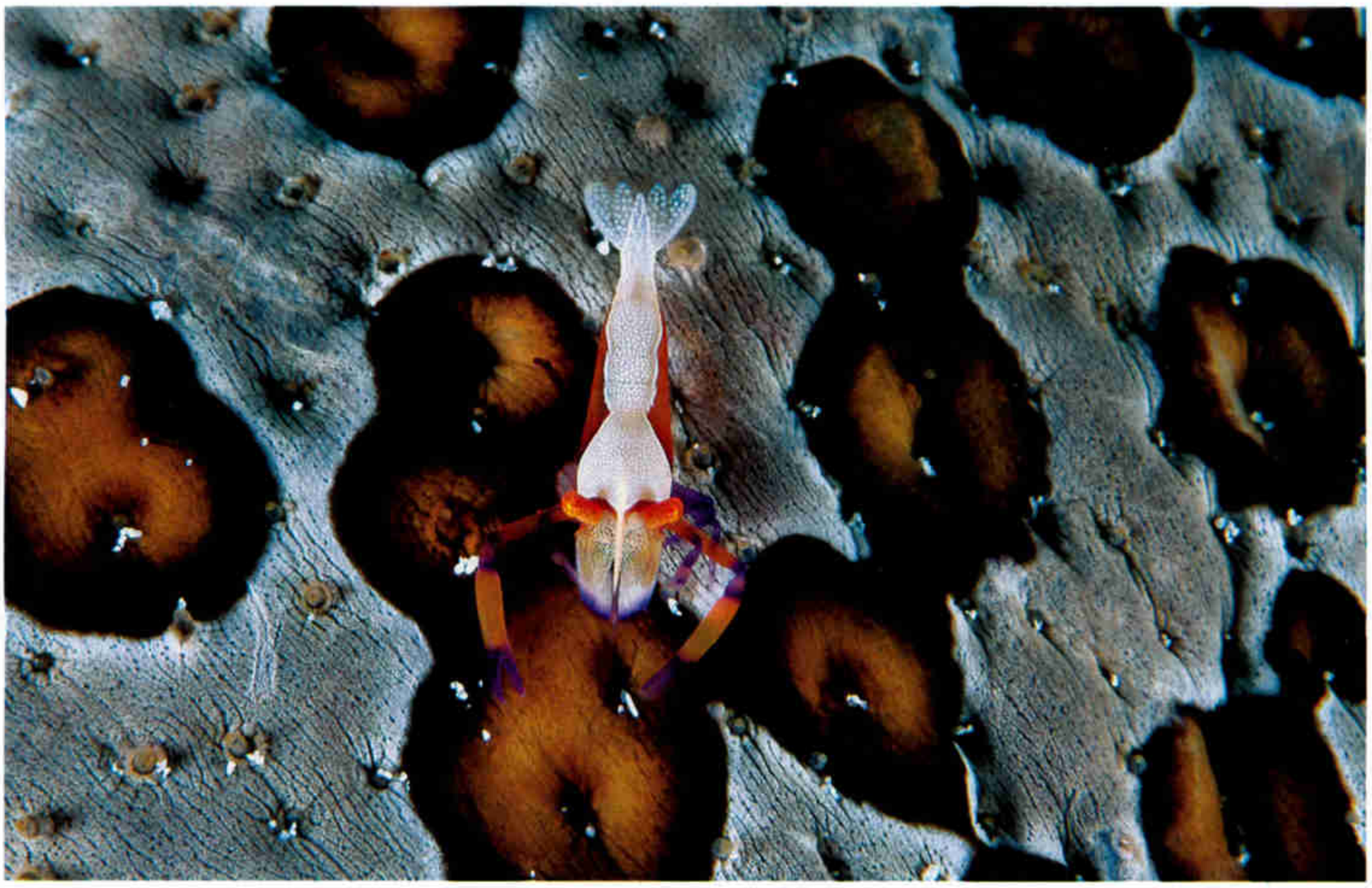
MOTTLED MUG *of a stonefish helps camouflage this prickly bottom dweller, which waits for prey to*



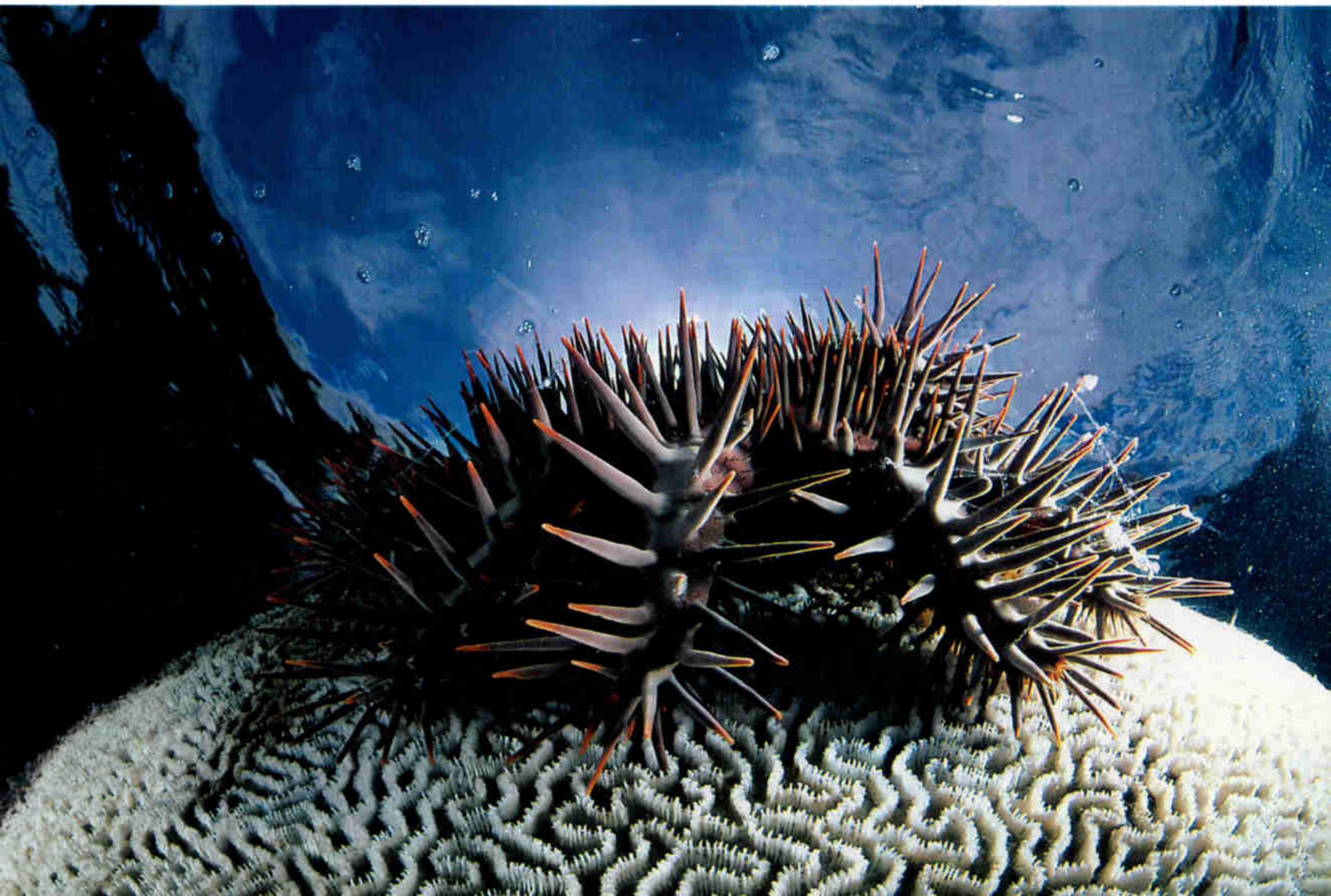
pass by. Thirteen poisonous spines—potentially lethal to humans—provide for its own defense.



IN THE CIRCLE OF LIFE *nothing survives in isolation. Amid a forest of pillar coral (above), a clown anemonefish can take refuge in the stinging arms of a sea anemone thanks to mucus on*



the fish's skin. A shrimp grazes across the surface of a sea cucumber (above), a porcelain crab picks a meal from an anemone (below left), and a crown-of-thorns starfish devours a brain coral.



WHY IS THE CAST *of characters here—including the harlequin tuskfish (above) and humphead wrasse (below right)—so colorful? "I'm afraid that's one of the reef's great unanswered*

then cooled down in the roped-off snorkeling area. Looking at the paddlers around me, I realized that one way or another, folk of every age and ability were getting to experience a world long beyond the reach of most travelers.

AFTER THE CAIRNS AREA the most visited part of the Great Barrier is the Whitsunday Group, islands located in the Central section, where reefs are more widely scattered than those farther north. The archipelago is a favorite of both foreign travelers and Australians on holiday, especially sailing enthusiasts. Since it sprawls close to the mainland, the waters aren't very clear. Yet when I submerged 30 feet off Hook Island, I found a thriving mix of hard corals. Among them was an even richer assortment of soft corals, swallow-tailed sea slugs with electric colors, and scores of fish new to me.

I never did identify the little yellow one that kept scooting up the loose wet suit sleeve of my diving companion, Amanda Parr. She and a boatful of locals were replacing marker buoys encrusted with marine growth. Such floats guide boaters to mooring buoys put in place to relieve anchor damage to the islands' reefs.

Alongside Parr, a dive instructor, were Tony Fontes, who trains dive instructors, and Elmer Ten Haren, who oversees dive operations for a tour company. These people make their living in the water. Here they were getting wet again on their day off and working for free. When I asked why, Ten Haren answered simply, "Because it needs to be done."

Neither the Queensland Parks department nor the Great Barrier Reef Marine Park Authority has the manpower to keep on top of all the chores called for along the vast reserve they are charged with managing. "That's where we come in," said Fontes, co-founder of a volunteer group that calls itself the Order of Underwater Coral Heroes. "We use our diving expertise to maintain buoys, clean junk off the reef, help with research projects, and educate the public. We didn't choose the name to sound noble. We liked the acronym O.U.C.H. It lets us tell people that's how coral feels when

you drag an anchor across it." Just the same, I added genuine heroes to the list of life-forms I had encountered along the reef.

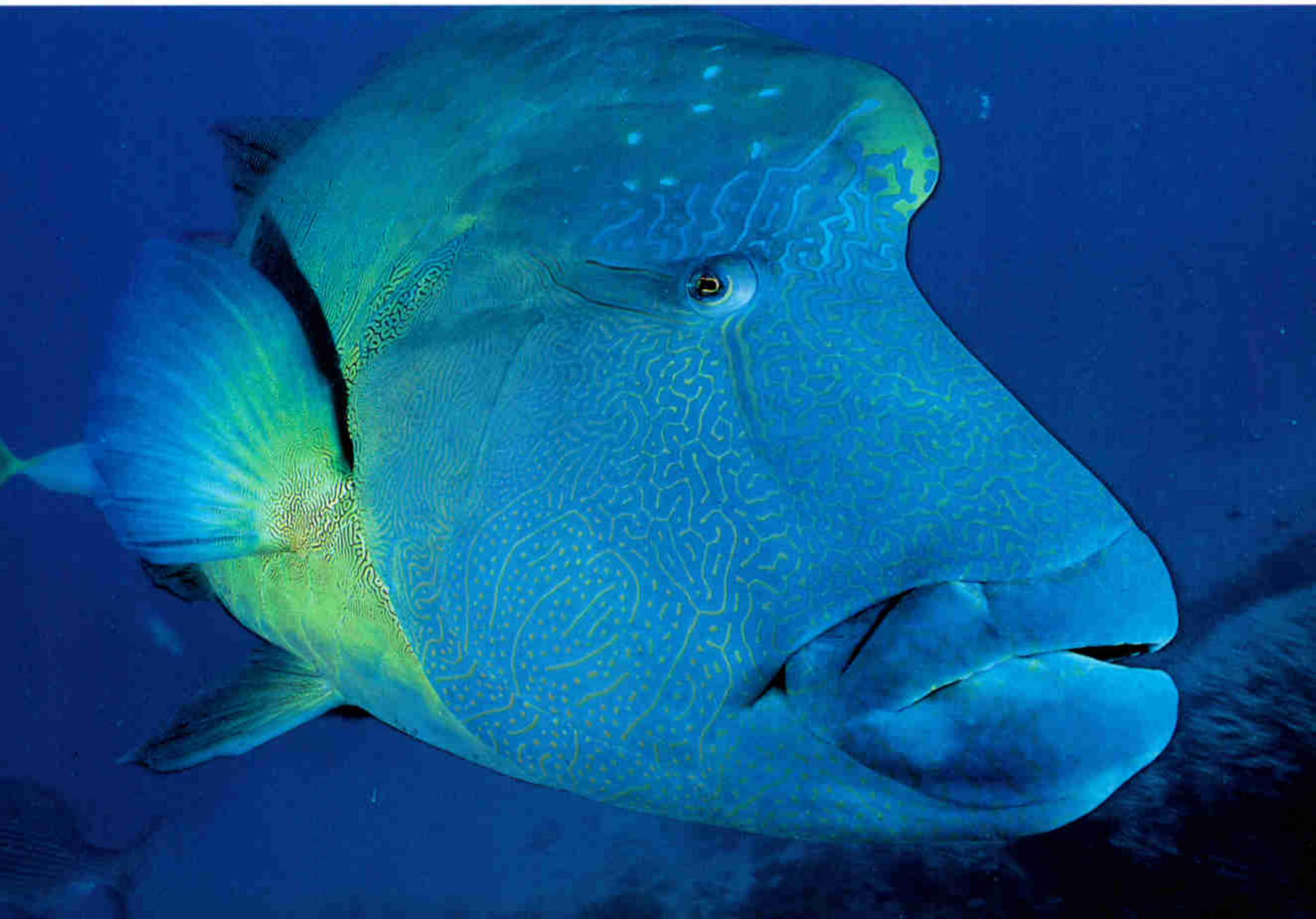
That list, growing longer hourly, led me to James Cook University in Townsville, the main coastal city along the Great Barrier's Central section. I wanted a professional opinion as to why reef life was such a parade of forms and hues. Why 20 look-alike butterflyfish species instead of, say, two or three?

David Bellwood, a leading marine ecologist, replied, "The answer is that we really don't know. But I can tell you that a lot of the diversity within groups of tropical fish is a matter of historical accident. It may be that as sea levels fell during the ice ages, ocean basins became isolated, and their populations evolved along separate lines, which we now regard as separate species. Later, when sea levels rose again, many migrated to Australia and took up residence side by side."

And the communities continue to flourish today. "The best management decision Australia ever made was to put its reef far offshore and along the northern end of the continent, which hardly has any people," Bellwood said jokingly. "We have some overfishing, but this is one of the few countries that has yet to make its big mistakes with coral ecosystems."

On the other hand, the coral realm is not immune to the changes taking place in ecosystems on land. Cane fields, other croplands, and development along Queensland's coastal plain have replaced many seaside wetlands, the natural filters for fresh water coming from the continent. Coupled with deforestation, overgrazing by livestock, and runoff from towns, farms, and industries upstream, this sends more sediments and nutrients flowing out toward the Great Barrier. The total has quadrupled since colonial times. Corals can persist in surprisingly murky water as long as tides and currents periodically sweep the sediments

questions," admits one marine biologist. One theory, though, posits that on a reef with nearly 2,000 species of fish milling about, splashy, distinctive hues enable a fish to quickly recognize one of its own.



off. It's the nutrients that wreck a reef. Anything beyond moderate levels of nitrogen hurts growth and reproduction in corals while fertilizing free-living algae that can smother their neighbors.

Drilling down into coral reveals distinct bands whose thickness is a measure of annual growth, rather like the rings in a tree trunk. "Our samples show that some reefs have stopped growing lately," Jon Brodie, a water-quality expert with the Marine Park Authority, told me. "We can tie this directly to higher nitrogen levels in the water coming out of rivers. But it's important to point out that when we say the Great Barrier Reef is at risk, we're only talking about portions of the inner reef so far. More remote areas and the outer reef as a whole are still in good shape."

Experts worry about an apparent rise in the frequency of bleaching, a condition whereby corals lose their symbiotic algae and turn white, most often when the water gets unusually hot. Prolonged bleaching kills corals. Yet as Terry Done, a senior research scientist at the Australian Institute of Marine Science, pointed out, disturbance and renewal are common in coral ecosystems and can even add to their diversity.

Reefs proceed from infancy to maturity, sometimes followed by senility, when erosion outstrips growth. At every stage corals are subject to periodic bleaching and crown-of-thorns outbreaks. Not to mention hurricanes; a typical reef on the Great Barrier gets hit every 20 to 50 years. "Before you make pronouncements about the health of any reef," Done concluded, "you have to know its age and where it stands in recovery from the most recent disturbance. We need to get away from the notion that reefs everywhere at all times should look like the perfect undersea garden in a travel brochure."

A WEEK LATER I was exploring a reef that, like the garden of biblical Eden, had a problem with snakes. After cruising steadily northeast from the port of Gladstone, we were a hundred miles offshore in the Swain Reefs complex of the Mackay/Capricorn section, the Great Barrier's widest belt of reefs. Sea snakes were everywhere, wriggling in and out of coral branches after small fish and eels. Though their venom is deadlier than a cobra's, these marine serpents aren't bad tempered as a rule, just unnervingly curious.

A five-foot-long olive sea snake followed my son, Russell, all the way around a reef, seemingly fascinated by his blue flippers, nosing them whenever he paused. Higher up I found David Doubilet staring through his camera viewfinder at a poisonous stonefish, oblivious to the fact that he had a far more toxic sea snake about to insinuate itself under one armpit and a shark checking out his other side.

We all needed thick rubber suits because the water here was several degrees lower than in the Far Northern section. The reefs' coral cover wasn't as dense as before, and there were fewer fish species, though the place was still a Mardi Gras of fins and scales. I was trying to tell several kinds of angelfish apart when a light-absorbing hulk the size of a minibus showed up. It was a 700-pound Queensland grouper. That afternoon still wider manta rays and eagle rays came flying through clouds of plankton in the tidal current.

A mother and baby bottlenose dolphin arrived toward evening for a long visit around the boat. Farther off more dolphins arced from a silken sea into a papaya-colored sky. But the calm within this shallow labyrinth of reefs was misleading. Crossing open water the next evening, the ship was taking ten-foot-high waves abeam and shuddering with each blow while the wind blew 40 knots in the thickening darkness and I made deals with God.

The lighthouse marking North Reef came into view long after midnight. "About bloody time," Capt. Norm Joseph growled as we made for the protected side. I had tried to analyze reefs in terms of geology, ecology, and management. At that moment I was merely grateful beyond words that reefs existed.

The next night I was lulled to sleep by the mewling of wedge-tailed shearwaters on southerly Heron Island, where seabirds gather by the tens of thousands each night during the nesting season. Our own long journey was nearly over.

After crossing the island to a research station

HORDES OF DIVERS *and other tourists descend on the reef each year, but with modest environmental impact thanks to strict regulations as well as focused flow of traffic: Some 95 percent of tourists visit just 5 percent of this maritime park.*

run by Queensland University, I met Ove Hoegh-Guldberg, whose research team may have made an intriguing discovery. "At shallow depths sunlight here can actually be toxic," he began. "Corals have special pigments to absorb the ultraviolet rays, and their symbiotic algae hide in the shade beneath bundles of these pigments for protection. Conversely, at depths where little sunlight penetrates, the algae nestle right inside the coral's pigment bundles. Then, as the pigments re-radiate the light energy they have gathered, the algae can use it for photosynthesis." This re-radiation causes corals to fluoresce—a phenomenon that Doubilet had photographed before anyone fully understood how or why it occurred.*

Beach walking away from the research station at low tide, I came upon adults bent over, scooping sand like kids making castles. They turned out to be students led by Adrian Jones, a University of Queensland marine ecologist. "I look at these flats as big green leaves," he said. "All sorts of microscopic algae and photosynthetic bacteria turn out to be living among the sand grains, and our measurements show that they put out as much oxygen as an equal area of tropical rain forest canopy. They also produce complex sugars that bind sediments and help keep the whole reef structure together."

A lifelong diver, Doubilet was always reminding me how the invention of scuba suddenly opened humanity's eyes to a realm that had remained a mystery since time immemorial. I pressed my toes into the warm, damp sand. How often had I strolled over bright tropical beaches, never imagining that they too were a scarcely known frontier suffused with one-in-a-million creatures?

Everything about the Great Barrier Reef felt like a revelation. To truly understand the rock-solid, organic fantasia that is a coral reef, we may need to assemble the most sophisticated knowledge, technology, and theorems available. Then again, maybe we will step back with a nod and say: This is what life on Earth does, given warm water, sunlight, and time.

MORE ON OUR WEBSITE

Zoom in on more underwater images and get technical tips from photographer David Doubilet at **nationalgeographic.com/ngm/0101.**

*See "A New Light in the Sea," by David Doubilet, NATIONAL GEOGRAPHIC, August 1997.

THE GREAT GATHERING

"We flew across a smooth, windless sea," says Doubilet, "and 2,500 feet below us, off the coast of Raine Island [left], I saw what looked like clumps of algae spinning in the sea. As we got closer, I realized my mistake. They were turtles, thousands

and thousands of them, impossible to count."

Scientists estimate that each year, during the months of November and December, some 10,000 endangered green turtles come ashore here each night to scoop out nests and lay their eggs, then struggle back across the sand to the sea (above). "We swam with young ones, old ones, battered ones, healthy ones, males trying to mate with as many females as they could," says Doubilet. "They all were afraid of me. Probably thought I was a shark." The turtles make the age-old journey from as far away as Papua New Guinea and Indonesia. "They're ancient mariners," marvels Doubilet, "endlessly crisscrossing the sea."

A GALAXY OF TURTLES *relies upon the Great Barrier Reef as a breeding ground—one more*

reason the United Nations in 1981 crowned this coral kingdom a World Heritage site. □

A CENTURY OF REVELRY IN PHILADELPHIA'S MUMMERS PARADE

Pumping their parasols in giddy unison, revelers in greasepaint and white satin frolic in the streets of Philadelphia on New Year's Day 2000. They're called Mummers (probably after the German word for disguise) —thousands of mostly white blue-collar guys who nearly every January 1 since 1901 have paraded through the city in wild array from head to spray-painted toe (above). At its peak in the 1940s the parade drew two million spectators. Today fewer than a quarter million come—so few that last year's route was cut from 2.5 miles to ten blocks. The Mummers remain defiantly merry. Says Tom Quinn, who rose before dawn to march, "I'm not out here for anyone but tradition."

KINGS *for a day*

UPHOLDING TRADITION *A Labor of Love*

It took two dozen pages to carry the gargantuan cape of one Mummer in 1947 (right). Competing under a system of arcane rules, Mummers clubs go to extravagant lengths to win bragging rights—and city prize money—awarded to those judged best on New Year's Day. In 2000 a battalion of marshals steered a 130-pound Carmen Miranda around City Hall to serve as a prop for the Avalon String Band's Broadway-style show. Two days before, captain Scott Moyer (left) marched the Greater Kensington String Band down a neighborhood basketball court for one last drill. "Professionals could learn this in a few hours, but these guys are truck drivers," joked a fan from the sidelines. "It takes them a few months." For longer than that the band sold raffle tickets and played weddings so that on January 1 they could trade work boots and jeans for glittering costumes costing up to $4,000 each. Playing for money and pride, a church band hired by a Mummers club warms up in the chill of New Year's morning. White Mummers in blackface once paraded. Since the practice was banned in the 1960s, more African Americans have joined the event.

BY KAREN E. LANGE
NATIONAL GEOGRAPHIC EDITORIAL STAFF

PHOTOGRAPHS BY VINCENT J. MUSI

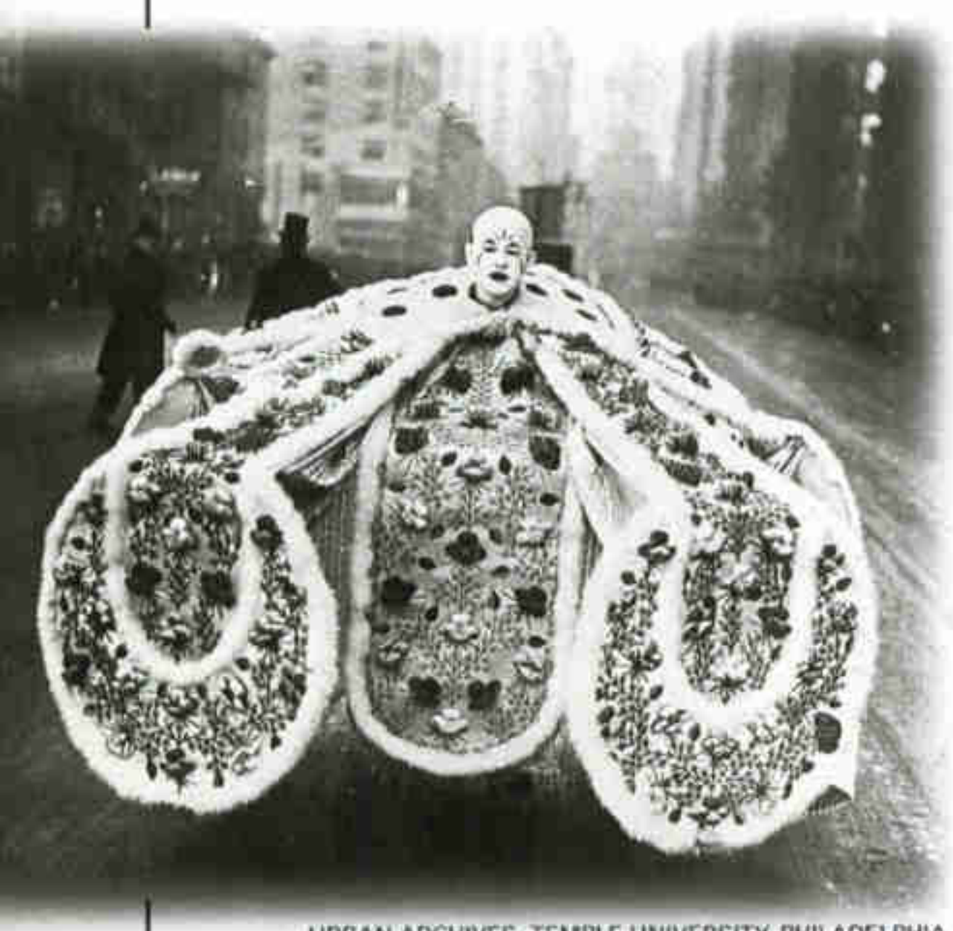
MUMMERS MUSEUM, PHILADELPHIA

FROM GLITTER TO GRIT *Long Day's Journey*

Charged up by the crowd, a spangled and spectacled Charlie Kueny of the Golden Crown club swings into a tightly choreographed finale as evening falls on the all-day parade. Last year "fancy brigades" like Golden Crown broke with tradition and turned off the parade route to finish in Philadelphia's cavernous convention center. There they staged elaborate shows for TV and busloads of tourists. Kueny danced as a frond of jungle foliage, holding a four-foot leaf. All around him zebras and apes gyrated to a percussive beat. At the climax a giant King Kong inflated in an explosion of confetti.

The exuberant costumes become more grandiose as the big day approaches. "Everything starts getting heavy because you keep adding mirrors and sequins," says Golden Crown captain Bill Burke. All this glitz came out of a humble row house on South Philadelphia's Second Street, affectionately known as Two Street. Here 19th-century immigrants formed clubs that took to the streets each January 1 in what Harper's Weekly *in 1888 called "an American reign of misrule." In 1901, with city sponsorship, they began parading downtown. The route change of 2000 put the parade entirely in the newly revitalized Center City, where patrons of pricey hotels could look down from their rooms and see the likes of Pat Goslin of the Durning String Band marching by in her feathered finery (below left). But that night the parade, as it always has, replayed on Two Street (right). Old people watched from windows, and babies in strollers sat by gutters strewn*

with beer cans. As rap music boomed, partyers spilled off sidewalks to do the Mummers strut—a freewheeling version of the high-stepping 19th-century cakewalk. "This is the real parade," said Mummer Stosh Visack. "This is God."



URBAN ARCHIVES, TEMPLE UNIVERSITY, PHILADELPHIA

Simply called "one of the clowns" by a local newspaper, this fellow (above) and his cape "attracted much attention" in the Mummers Parade of 1921. Generations later a costumed father and son arrive on Two Street to carry on the Mummer tradition, handed down by families in South Philadelphia's tight-knit Italian, Irish, and Polish neighborhoods. Many of those families have scattered to the suburbs, and most people now watch the Mummers on TV. But the parade endures. "They will always have it here," says Avalon captain Charlie Nicholas. "There will always be a Two Street." □

MORE ON OUR WEBSITE

Continue the celebration online and view historical photographs from Philadelphia's Mummers Museum at **nationalgeographic.com/ngm/0101.**

SAMSON GOLIATH HEROD ALEXANDER RICHARD THE LION-HEARTED MAY HAVE WALKED THE STREETS OF ASHKELON ANCIENT CITY OF THE SEA

For nearly 5,000 years Ashkelon was one of the great seaports of the Mediterranean. By the time this Byzantine mosaic in Jordan marked it as a regional power, the city's final destruction in the Crusades was a mere five centuries away.

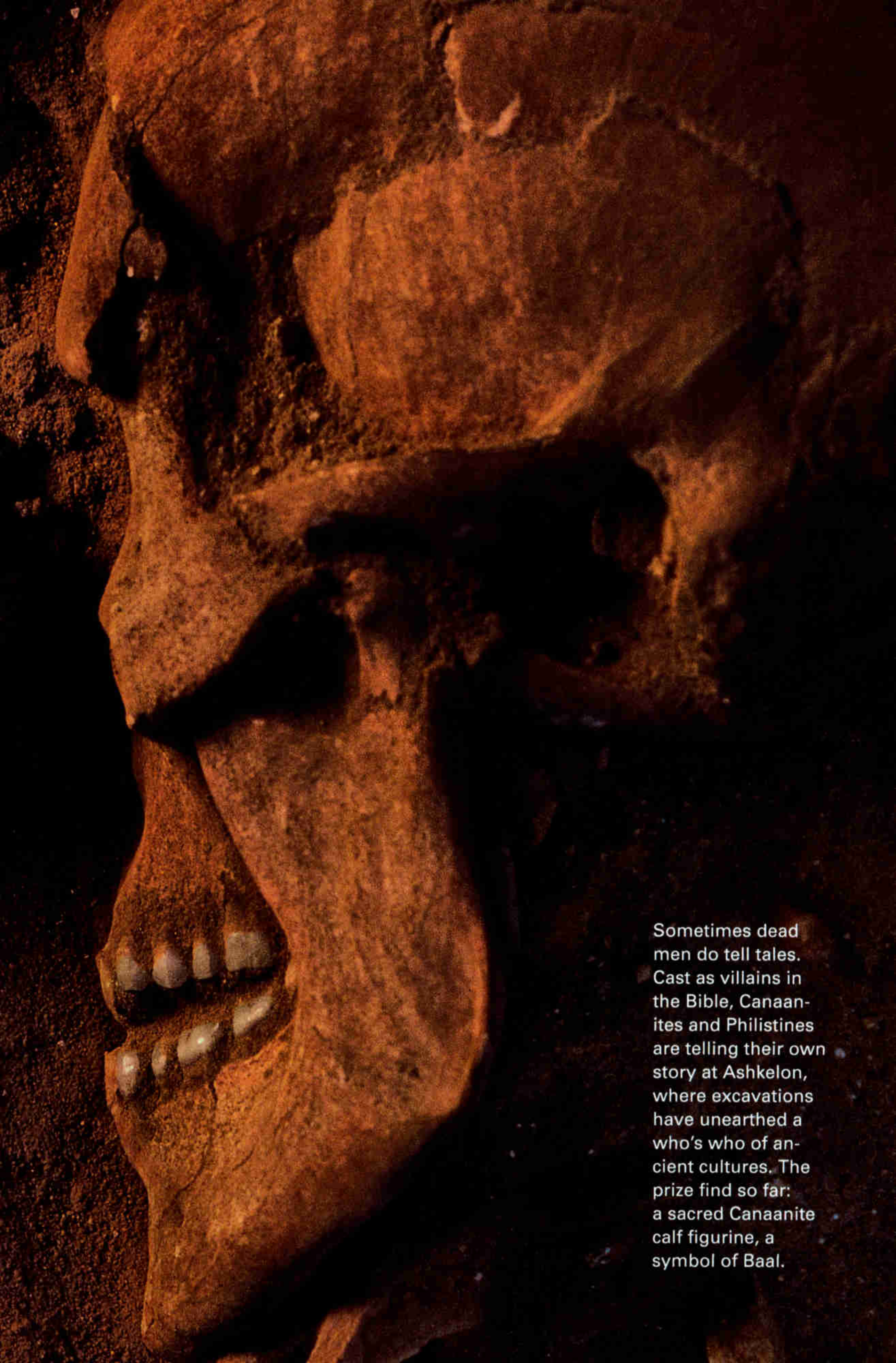
BY RICK GORE SENIOR EDITOR

PHOTOGRAPHS BY ROBERT CLARK

"THEY'VE FOUND A NEW 'BANANA' IN GRID 50." Tracy Alsberg, a young archaeologist from the University of Chicago, is passing on the morning scuttlebutt from the dig at the ancient city of Ashkelon on the Mediterranean coast of Israel.

I have taken a break from the sweltering July heat and humidity to browse through 14 years of excavation records at her team's field office in a nearby hotel, but the new banana sends us back into the sun.

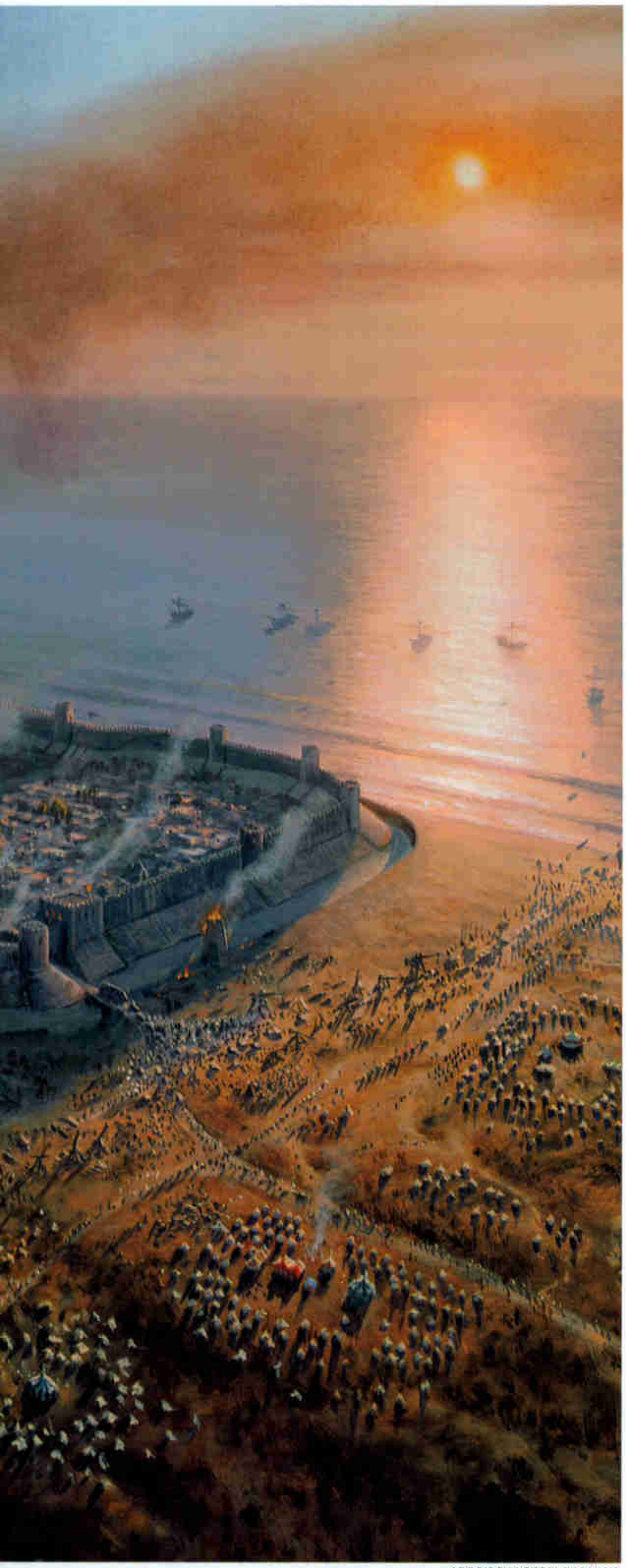
"Banana is our code word for human skeleton," explains Alsberg as we head over to grid 50, one of three active dig sites at Ashkelon this field season. In Israel, she explains, some Orthodox Jewish groups believe that human remains should not be disinterred. The previous season, members of one of those groups staged a protest after



Sometimes dead men do tell tales. Cast as villains in the Bible, Canaanites and Philistines are telling their own story at Ashkelon, where excavations have unearthed a who's who of ancient cultures. The prize find so far: a sacred Canaanite calf figurine, a symbol of Baal.

WAR in the

city of the ages



ART BY CHRISTOPHER EVANS

hearing that archaeologists were excavating skeletons from tombs of well-to-do Canaanites, pre-Israelite settlers of ancient Palestine. So this season team members speak in code.

Today Ashkelon is a forgotten name outside of Israel, and even there people know it mainly as a beachside city whose national park fills with bathers and picnickers on weekends. But as far back as 3500 B.C. Ashkelon was a major seaport.

Strategically located on the trade routes from Turkey and Syria to Egypt, it witnessed the rise and fall of numerous cultures besides the Canaanite, including Philistine, Phoenician, Greek, Roman, Byzantine, and Crusader. The biblical Goliath probably walked its streets, as did Richard the Lion-Hearted, Alexander the Great, Herod, and Samson before he met Delilah. It was destroyed in 604 B.C. by the Babylonian king Nebuchadrezzar and again, for the final time, in A.D. 1270 by the Mamluks, the Islamic dynasty that ruled Egypt at the time.

Buried for centuries beneath its accumulated rubble, covering about 150 acres, Ashkelon has recently been emerging from obscurity. Since 1985 a team of archaeologists led by Lawrence Stager of Harvard University has found a trove of artifacts that reveal details about everything from the burial customs to the

When Muslims defended Ashkelon from Crusaders in A.D. 1153, their fortifications were built over earthen ramparts erected by Canaanites 3,000 years earlier. Situated on a sandstone outcropping atop an underground river, the 150-acre city was a strategic linchpin in this arid, hotly contested region.

CANAANITES BUILD A CITY

Standing where many a chariot has gone before, Harvard University archaeologist Lawrence Stager surveys the oldest arched gateway ever found. In roughly 1850 B.C. Canaanites—the people inhabiting the land of Canaan, later called Palestine—built this vaulted corridor with arched gateways on either end when they raised Ashkelon's mud-brick north wall (below). The city's walls were built on ramparts that were up to 50 feet high and 150 feet thick at the base, embracing the city in an arc nearly a mile and a half long. They were difficult for enemies to penetrate—and necessarily so. Ashkelon was one of the largest and richest seaports in the Mediterranean under Canaanite rule. With plentiful fresh water and fertile soil, it was a major exporter of wine, olive oil, wheat, and livestock. Until Egypt conquered the Canaanites about 1550 B.C., the city was a scourge of the pharaohs, who cursed Ashkelon's kings.

ART BY CHRISTOPHER EVANS

ART in the city

sexual practices of the people who lived there.

Alsberg and I meet Stager at grid 50, which fronts the beach. He is a large and cheerful man, and nothing can put fire in his eyes faster than word of a new find. Despite temperatures pushing 100°F, he charges down the path that over the years his team has excavated through Islamic, Byzantine, and Roman occupations. We descend through layers that contain the foundations of storehouses built between 500 and 350 B.C., during Ashkelon's Persian–Phoenician period, to hold the town's abundant imports and exports. Then we pass a group digging out a building from the 13th century B.C., the closing era of Canaanite Ashkelon.

The Canaanites, a people who probably originated in eastern Syria, had begun migrating down the Mediterranean coast about seven centuries earlier. "They came by the boatload," says Stager. "They had master craftsmen and a clear idea of what they wanted to build—big fortified cities."

The Canaanites made Ashkelon a major center of trade, exporting wine and olive oil throughout the eastern Mediterranean. Stager's team recently found evidence of the cosmopolitan nature of Canaanite Ashkelon—part of a 13th-century tablet used to teach scribes languages. The tablet had one column of Canaanite words, which would have

of the Philistines

The Philistines of the Bible were such brutish destroyers that their name has become an epithet reserved for the dullest enemies of art and knowledge. But the picture from Ashkelon is altogether different. While the Israelites were making crude, unadorned pottery, Philistines were decorating theirs in sophisticated styles resembling those of Mycenaean Greeks. They later imported Greek pottery like these seventh-century B.C. "wild goat style" pieces (left). In fact, they were almost surely of Greek origin themselves, crafting pieces like this Mycenaean mother goddess (right). One of the half dozen or more Sea People who swept through the eastern Mediterranean coast around 1175 B.C., Philistines ruled Ashkelon for 600 years and dominated four other major cities in the region.

matched up with two or three adjacent columns containing equivalent words in different languages. Based on complete tablets found in Syria, linguists suspect that one column would have been a Semitic language called Akkadian, another an unrelated tongue, possibly Hurrian or Hittite.

Discovery seems continuous at this site. A student volunteer excitedly greets Stager with an Egyptian amulet of the baboon god. An older volunteer brings him a pottery sherd with a branching symbol painted on it. With one glance he identifies the symbol: "It's a Late Bronze Age tree of life."

When we reach the bottom of the grid, we enter the City of the Dead—a cluster of Canaanite burial chambers. So far the team has found 16 chambers, and Stager believes that there may be dozens more. Each was connected to the surface by a shaft.

"Families would bring their corpses down here," says Stager, "and put them in the middle of the chamber until the flesh rotted off. That could take several months. Then they'd place the bones in recesses and corners. Over time those families would have had quite a few ancestors buried here."

In a chamber about ten feet in diameter three members of the team huddle over the skeleton they found this morning—a child

about two years old. The youngest Canaanite skeleton uncovered at that point, it has been nicknamed "Baby."

Baby gives the team a new piece of information about Canaanite culture. It was buried with Egyptian scarabs, or magical charms, around its neck, indicating that children were given full status in Canaanite culture. In subsequent finds, children even younger were similarly buried.

Later that day I see Baby again. Netta Lev-Tov, a physical anthropology student, is cleaning and measuring the bones under a sunshade near the hotel where the team stays. Besides Baby, Lev-Tov is working with the remains of three adult males that the team has whimsically named Franky, Johnny, and Mr. Man.

"These were robust men," she says. "They were muscular and had very manly jaws. These people ate dust every day. Sand got in their food and wore their teeth down quickly."

The teeth intrigue specialists like Lev-Tov for another reason. DNA from dental interiors may one day enable scientists to determine how closely these buried people were related to each other as well as to other Mediterranean populations, both ancient and modern.

THE CANAANITES fascinate Stager, partly because so little is known about them. They and the Philistines are largely what drew him to this forgotten site. In 1985 he got an opportunity most archaeologists only dream about. Leon Levy, a wealthy U.S. businessman and connoisseur of ancient art, was impressed by his record and offered to finance the excavation of any site Stager chose. He settled on Ashkelon.

Although archaeologists knew Ashkelon's location from its crumbling medieval walls, few had dug in the tell. In 1815 a wealthy Englishwoman, Lady Hester Stanhope, found part of a Roman-era basilica while searching for a treasure marked on a medieval monk's

Just a mile or so from modern Ashkelon, the ancient city is protected as an Israeli national park. Small parts had been explored starting in the early 1800s, but a comprehensive dig didn't begin until 1985 because of the difficulty and expense of sifting through so many centuries and cultures. Only about 2 percent of the site has been excavated. Much of it has already been claimed by the rising sea.

map. In the early 1920s John Garstang, a British archaeologist, tried to find the layers containing Philistine buildings. Although his team discovered Philistine artifacts at the bottom of two trenches they dug, they abandoned the project. There were simply too many layers from later cultures to dig through.

Ashkelon posed no less of a challenge to Stager, but with ample funds he began digging, and found the Canaanites much more quickly than he had expected.

"This is where we first started to realize the magnitude of this place," says Stager, as we stand alongside an ancient moat a few hundred feet in from the beach. We are looking up at a 50-foot-high sloping earthen rampart covered by row after row of fieldstones. As imposing as this barricade is, it is merely the base of a great wall with towers built by the Canaanites in 1850 B.C., a century after they reached Ashkelon. That towered wall probably rose another hundred feet and formed an arc 1.4 miles long around the city. It protected some 15,000 inhabitants—quite large for an ancient city. By comparison, Babylon at this time might have had a population of 30,000.

The rampart was an extraordinary 150 feet thick—a defensive necessity, says Stager. "Armies besieging a city used to dig tunnels under its rampart either to sneak into the city or to undermine the structure, causing part of the wall to collapse."

Stager's team discovered the rampart by luck in 1987. The operator of a nearby resort had illegally sent a bulldozer to the site to dig sand for making concrete. The bulldozer scrapings exposed mud bricks and some pottery that the ancients had thrown into the base of the rampart. Working with picks and wheelbarrows over the next 12 excavation seasons, which last about two months each summer, team members exposed a 900-foot-long stretch of the rampart as well as a moat that lay before it. They also uncovered the oldest known arched gateway in the world. More than 8 feet wide, 12 feet high, and lined with mud brick, it was built as part of the great towered wall in 1850 B.C.

In its prime this gateway would have bustled with activity. Oxcarts and donkeys laden with produce from the countryside or goods from ships in the harbor would have labored up a sloping road to pass through the portals. Sailors and merchants speaking a babel of tongues entered with goods from Egypt, Crete, Turkey, and Syria. Ashkelonian goods would likewise have flowed out of the gateway.

Near the bottom of the steep slope leading to the gateway, many voyagers stopped at a sanctuary discovered in 1990. As the excavators dug through the crumbled debris, they came across a silver-coated bronze figurine of a bull calf—a symbol of Baal, the Canaanite storm god. Four inches tall and dating from 1600 B.C., the calf lay within its own shrine, a beehive-shaped pottery vessel (page 68). Apparently travelers paused at the sanctuary either to beg the storm god's protection for their journey or to give thanks for safe arrival.

Now on display at the Israel Museum in Jerusalem, this little calf, with one horn missing and only patches of its silver plating remaining, evokes the idolatrous calf worship by Israelites that so outraged Moses in the Bible. Though the Israelites did not emerge until several centuries after the Ashkelon

figurine was made, they were probably derived from the same cultural stock as the Canaanites. The calf perhaps symbolized the common past the two groups shared, a past that the Israelites rejected as they developed their own identity.

As Canaanite Ashkelon prospered, its army grew strong. Historians have long known that around 1650 B.C. a mysterious group of warriors called the Hyksos invaded the Nile Delta and ruled it for a century. No one knew where the Hyksos, which means "foreign rulers" in ancient Egyptian, came from. Recent excavations at Avaris, the Hyksos capital in Egypt, have produced artifacts identical to those found in Ashkelon, leading Stager to propose that the Hyksos were actually Canaanites and that many came from around Ashkelon.

Even before the Hyksos conquered the delta, the Egyptians were having trouble with the Canaanites. Pharaohs of the 12th dynasty (1938-1755 B.C.) cursed three kings of Ashkelon in so-called execration texts. Scribes would write the names of the kings on ceramic bowls or human figurines, and the pharaoh would smash them to magically destroy their power.

We have an idea what the Canaanites looked like from artwork painted on an Egyptian wall around 1900 B.C. that depicts Canaanite dignitaries visiting the pharaoh. They had Semitic facial features and dark hair, which the women wore in long tresses and the men styled in mushroom-shaped bundles on top of their heads. The men had trimmed beards. Both sexes wore bright red and yellow clothes—long dresses for the women and kilts for the men.

AROUND 1550 B.C. the Egyptians expelled the Hyksos and for more than 300 years dominated Canaan, the land from present-day Lebanon to the Sinai. Beginning in the late 13th century, numerous groups of invaders threw the entire eastern Mediterranean into turmoil. Around 1175 one group, the Philistines, conquered Ashkelon and established at least four other major cities in the region, which became known as Philistia—echoed still in the name Palestine.

Because their pottery and other artifacts resemble those of the Mycenaean Greeks, the warriors who sacked Troy in the Homeric legends, Stager believes that the Philistines were in fact immigrant Greeks. The Philistine hero Goliath, says Stager, wore Mycenaean-style battle gear. The biblical Samson, he adds, behaved like the legendary Greek superhuman Heracles. And Samson's loss of strength after the Philistine woman Delilah cut his hair parallels an earlier Greek myth.

Analysis of animal bones found in Philistine Ashkelon indicates that the newcomers ate a lot of pigs, an unusual practice in Canaanite times but very common among early Greeks.

"I think pork became taboo among the Israelites," says Stager, "in part because that helped set them off from their archenemies—those uncircumcised Philistines."

The Bible is the only lengthy written source on the Philistines, and since the Israelites waged war with their neighbors for two centuries, the name Philistine became a synonym for unsophisticated and boorish people. But the excavations at Ashkelon and other Philistine sites have turned up evidence that they were actually quite cosmopolitan, fond of artful pottery, and distillers of fine wine.

Still, much remains to be learned, and the Philistines are now the primary focus at Ashkelon, mainly because the team is digging in the levels that date close to the time they arrived. Stager hopes soon to find a layer of destruction—charred wood and ruins—that would signal the burning of the Canaanite city when the Philistines invaded. Stager takes me to grid 38, which at about an acre in size is the largest site on the dig. Here the team is closest to the earliest Philistines.

"These are all Philistine streets," says Stager as we walk through a complex of foundations of mud-brick buildings from the 12th century B.C. In earlier seasons at this grid the team excavated a commercial building from the seventh century B.C. that measured 90 feet by 36 feet. Stager suspects that it was a winery with storehouses.

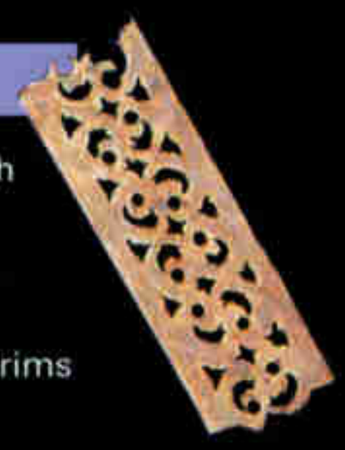
This season has brought more clues to Philistine traditions—a pot with the bones of a puppy inside. Buried beneath the foundations of a building, the find intrigues a team of animal-bone specialists headed by Paula Wapnish of the University of Alabama. "We think that somebody killed it, put it in the pot, and placed it into a pit in the ground," explains a team member, Brian Hesse. "The pot has char marks. I think someone was probably cooking the puppy for food but never came back for it."

Or, counters Stager, the puppy was buried in

A CITY BUILDS ON SUCCESSES AND FAILURES

ISLAMIC A.D. 640 - 1153

Muslims adorned furniture with carved-bone inlays during a 500-year rule. When they took Ashkelon in 640, the city was a landing place for Christian pilgrims en route to the Holy Land.



ROMAN/BYZANTINE 37 B.C. - A.D. 640

Ashkelon boomed during the Byzantine era, trading all along the Mediterranean and Black Seas. This type of amphora moved vast amounts of wine in the fourth to sixth centuries.

HELLENISTIC 332 - 37 B.C.

Alexander the Great's conquest of Ashkelon planted an enduring Greek influence. This amphora handle comes from Rhodes, then a commercial hub of the Mediterranean.

PERSIAN/PHOENICIAN 538 - 332 B.C.

In the Persian era the Phoenicians raised Ashkelon out of the ashes of its 604 B.C. destruction by the Babylonians and back into prosperity. This bust was imported from Cyprus.

PHILISTINE 1175 - 604 B.C.

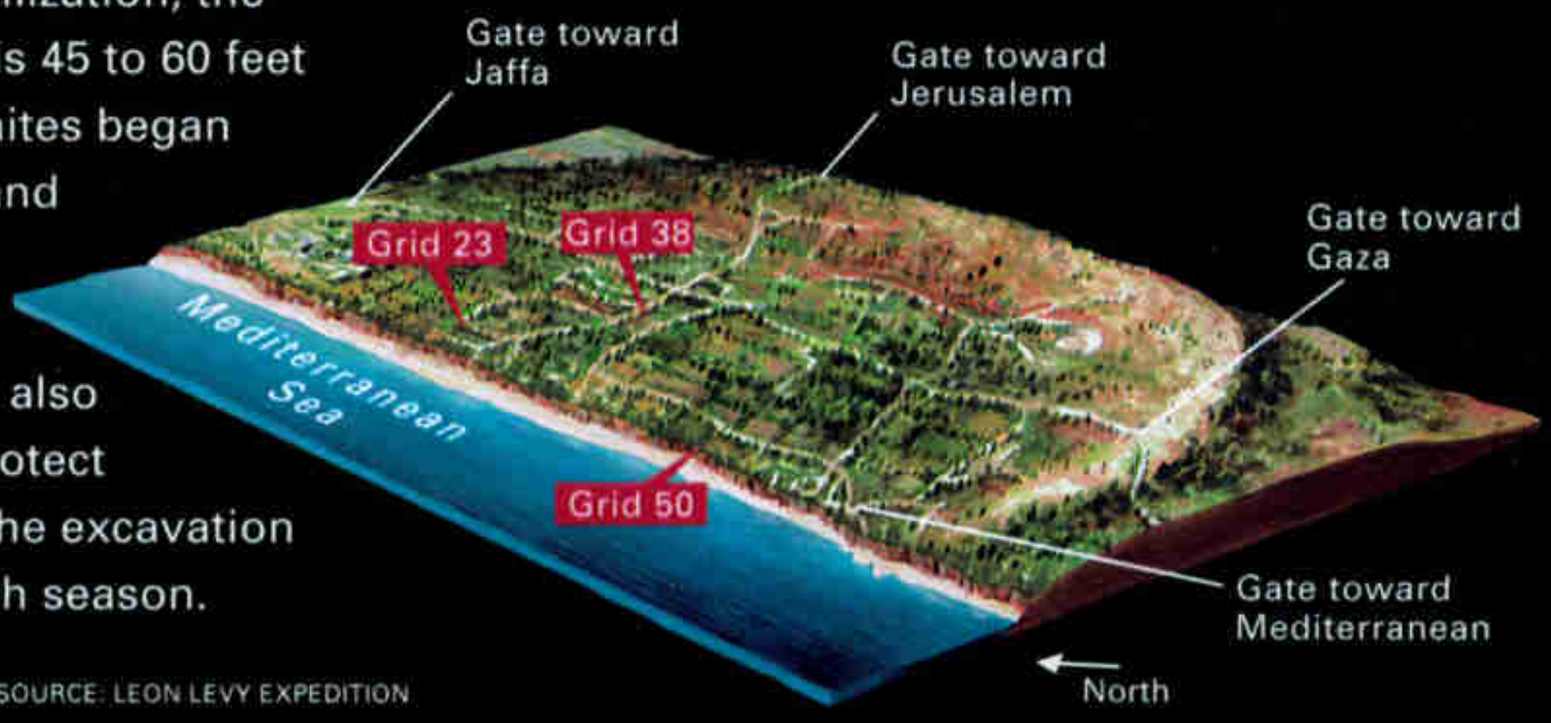
The seafaring Philistines brought early Greek culture to Ashkelon. A chariot axle pin, topped with the head of a deity, reveals their technological prowess and their likely Aegean origin.

CANAANITE 1950 - 1175 B.C.

First people thought to have had an alphabet, Canaanites copied the same Egyptian hawk motif as the Hyksos—probably also Canaanites—who conquered Egypt about 1650 B.C.

SCALE OF ARTIFACTS VARIES

When civilization builds upon civilization, the land adds up. The Ashkelon site is 45 to 60 feet higher than it was before Canaanites began living there, and pottery sherds and other evidence show that the site was occupied 1,500 years before then. Walls and ramparts, also cumulative endeavors, helped protect populations of 15,000 or more. The excavation team digs at only a few grids each season.



NATIONAL GEOGRAPHIC ARTIST CHRISTOPHER A. KLEIN; SOURCE: LEON LEVY EXPEDITION

A collage of Ashkelon artifacts hints at the panoply of cultures and individuals that made their mark on the resilient city, destroyed and rebuilt many times. Like other port cities, Ashkelon for much of its history hosted a diverse population—mixing local peoples with

foreign merchants and serving as an exchange point for customs, languages, and ideas. Most of all, in the words of a 12th-century Arab, "Ashkelon was a town likable to the heart, with firm walls and mighty structures, which people liked to inhabit."

DOGS in the

an already charred pot as an offering to bring good fortune to the building.

Shortly before we arrived at grid 38, excavators had turned up another Philistine burial. In the corner of one room Lev-Tov sits carefully brushing dirt from the skeleton of a human infant that had been buried in a pit. The tiny brown bones and skull barely emerge from the earth that has so long encased them.

The excavators are trying to determine whether the child was intentionally buried inside the house, perhaps for good fortune like the puppy in the pot. Or it could have been buried in a courtyard that was later built over.

There is little doubt, however, about what one Philistine layer at Ashkelon represents—the total destruction of the city in 604 B.C. by the armies of Nebuchadrezzar, the Babylonian king. Standing on the floor of an older Philistine house in grid 50, Stager points at a shoulder-high layer of charred wood and debris in the excavation trench. On the floor of a nearby building the team found the skeleton of a woman in her 30s whose skull had been crushed by a blunt instrument.

"She was probably killed by a Babylonian soldier," says Stager.

Nebuchadrezzar apparently burned Ashkelon to frighten other cities that might ally with his rival, Egypt. His soldiers took many

city of the Phoenicians

By the late sixth century B.C., Persia ruled the greatest empire the world had known, stretching from India to the eastern Mediterranean. Though under Persian sway, it was the Phoenicians—actually latter-day Canaanites who became famously successful sea traders—who defined the culture of Ashkelon in the Persian era. Excavators have found Phoenician religious symbols such as the "sign of Tanit" (below) and items indicating widespread trade, such as this Greek cup. Most intriguing is the dog cemetery: a thousand dogs, carefully arranged, suggesting a reverence that may have bordered on worship.

of the surviving residents back to Babylon. About 75 years later the Babylonians were conquered by the Persians, who encouraged Phoenician allies from Tyre, a city in what today is Lebanon, to rebuild Ashkelon. Ironically those coastal people were descended from the Canaanites.

The Phoenicians were great traders and a powerhouse in the Mediterranean. Their era brought renewed prosperity to Ashkelon and left an unexpected legacy for archaeologists—a large cemetery filled with a thousand dogs.

"The dogs apparently died naturally," says Hesse. "They show no trauma or cut marks from being butchered. They were carefully laid on their sides in a shallow pit with their tails wrapped around their hind legs."

The dogs were buried in the first half of the fifth century B.C., and Stager believes that they reflect a short-lived dog cult. "Dogs were associated with healing in many cultures because they lick their sores and wounds," he says.

Ashkelon residents also began using coins during this era and eventually had one of the most active mints in Palestine, issuing coins almost continuously from the fourth century B.C. to the 12th century A.D. Stager's team has uncovered several hoards, now at the Israel Museum. There curator Haim Gitler displays a hoard of 31 tiny silver coins known as obols

SEX in the city

that date from around 400 B.C. Although from the region, they feature the head of Athena, the Greek goddess.

"Someone stashed them away, then died or disappeared," says Gitler. Since most of the coins are identical, Gitler suspects that they came from the local mint.

The prosperity of the Phoenician era and the subsequent brief rule of Alexander the Great ended abruptly about 295 B.C., when Egypt's ruler Ptolemy I destroyed the city. But Ashkelon bounced back and gained fame not only as a commercial emporium but also as an intellectual center. One Ashkelonian, a man named Antiochus, went to Athens to head up the philosophical academy there, where he tried to reconcile the theories of Aristotle, Plato, and later philosophers known as the Stoics, who stressed the importance of both fate and reason in determining human lives. Dorotheus of Ashkelon wrote a dictionary of Attic Greek, the dialect spoken in Athens. Other Ashkelonians were noted in a variety of inscriptions found in the eastern Mediterranean.

ASHKELON CONTINUED TO FLOURISH under Roman rule, which started in 37 B.C. The Romans put a heavy stamp on Ashkelon, building villas, theaters, and large basilicas. Some scholars say that King

of the Romans

Romans brought their own sensibilities to Ashkelon, building fountains, theaters, and basilicas and living in villas with terraces, gardens, and—in one case at least—erotic lamps. Scores of palm-size ceramic oil lamps with mythological and sexual themes (left) were found in a villa in a wealthy part of town. Never lit, they were probably part of a private collection that may have presaged the next occupant of the lot—a fourth-century A.D. bathhouse that perhaps doubled as a brothel. Nearby, excavators found the remains of more than a hundred infants in a sewer; they may have been the unwanted progeny of prostitutes from the brothel. It's unknown whether Romans here had African slaves, as they did in other locales, but a Nubian figurine (right) suggests some familiarity with Africans, whom they considered exotic.

Herod the Great was born in the city, and therefore it benefited from his enthusiasm for public building projects. According to Josephus, a Jewish historian, Herod constructed baths, ornate fountains, grand colonnades, and a palace intended for the emperor Augustus.

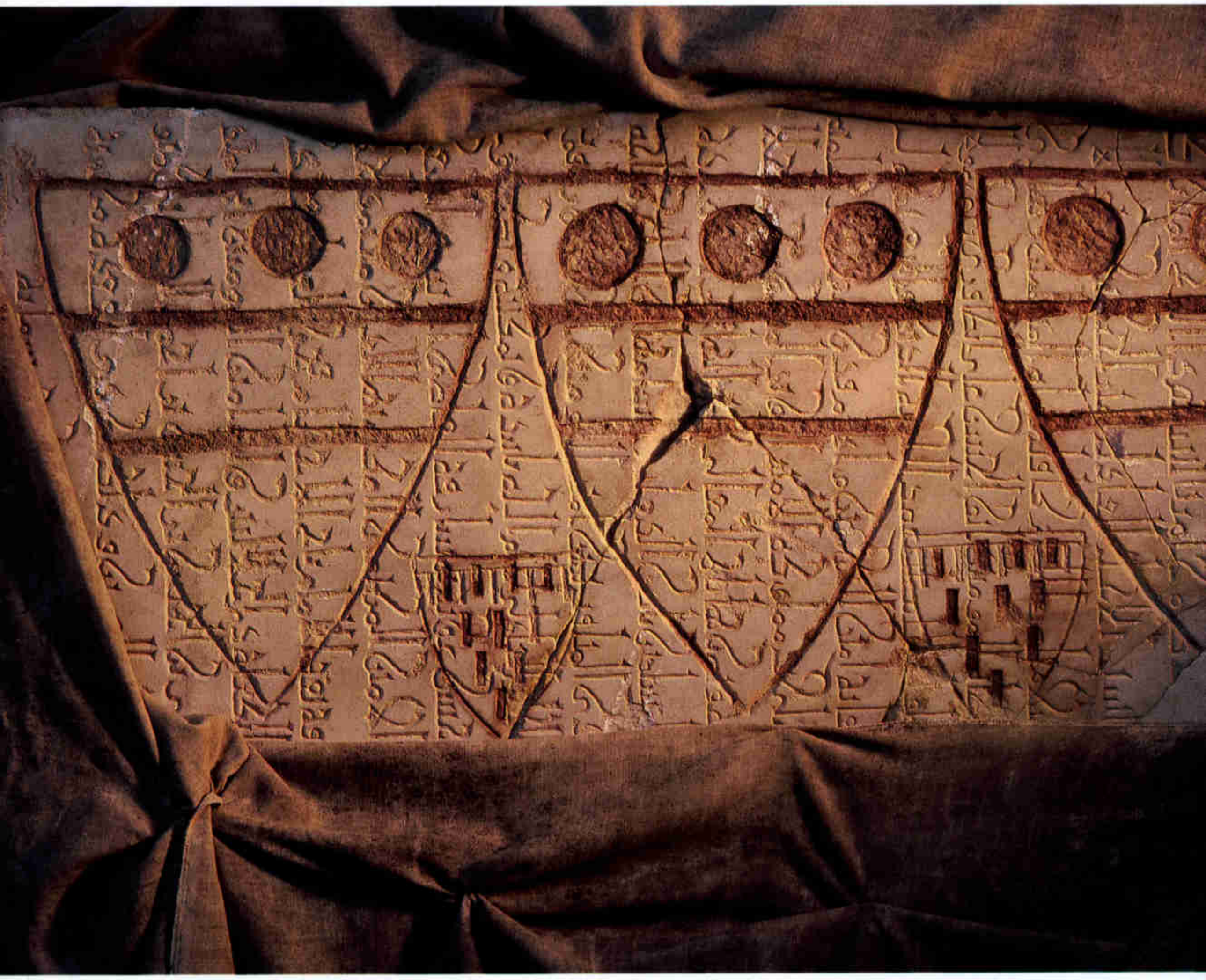
During Roman times Ashkelon expanded as an international emporium. It profited from agricultural exports, notably wine, olive oil, wheat, henna, dates, and onions. The small green onion known as a scallion took its name from the city's Roman name, Ascalon.

Prosperity brought grand villas with large terraces and gardens overlooking the sea. In one of those villas Stager's team unearthed the sherds of some 150 ceramic oil lamps, many with sexual motifs. Couplings depicted on the lamps seem right out of Sodom and Gomorrah, but Roman sexual mores in pagan Ashkelon were far looser than those of neighboring Jewish and Christian communities. Stager suspects that the lamps belonged to a collector.

In the fourth century A.D. a bathhouse was built over the villa containing the lamps. Stager's team uncovered part of the plastered rim of one tub that read "Enter, enjoy, and. . . ." The bathhouse might well have been a brothel in Ashkelon's red-light district.

Excavation of an ancient sewer under the bathhouse revealed one of Stager's most

GRAFFITI in the



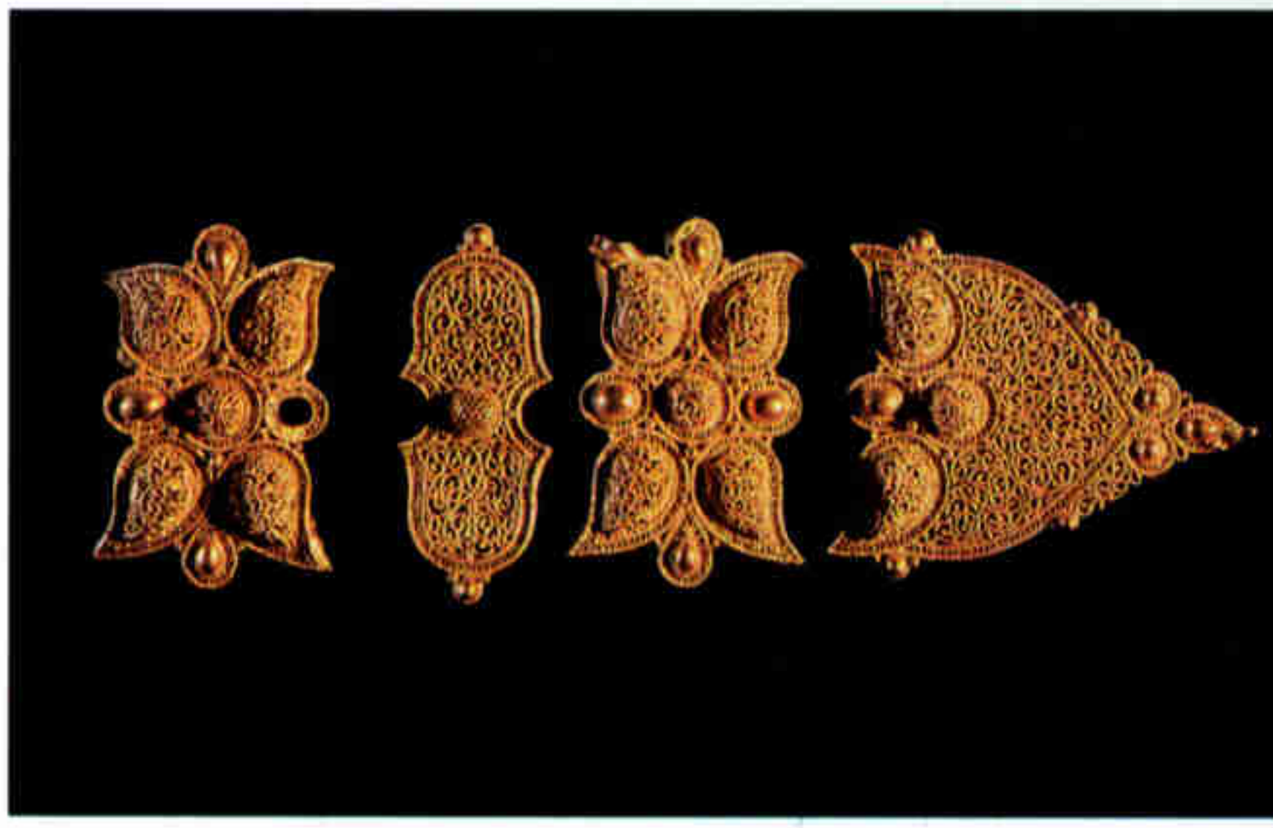
unsettling discoveries—the fragile bones of more than a hundred infants. The newborns had been thrown into the gutter, along with animal bones, pottery sherds, and a few coins.

"We know that infanticide was widely practiced by the ancient Greeks and Romans," says Pat Smith, a physical anthropologist at Hebrew University in Jerusalem who studied the bones. "It was regarded as the parents' right if they didn't want a child. Usually they killed girls. Boys were considered more valuable—as heirs or for support in old age. Girls were sometimes viewed as burdens, especially if they needed a dowry to marry."

Two of Smith's colleagues, Marina Faerman and Gila Kahila Bar-Gal, determined the sex of the infants using DNA-based techniques. Many skeletons were incomplete, but the two scientists did salvage 43 left femurs, or thigh bones. Nineteen yielded DNA that could be analyzed. Of those, 14, or 74 percent, were male. Puzzled by this apparently high percentage of boy babies killed, the researchers speculate that these infants were the unwanted offspring of courtesans serving the bathhouse. The proprietor or courtesans might well have reared some children to pursue the same profession; the excess would have been killed and discarded. Although both sexes worked as prostitutes in the Roman world, the researchers believe that

city of the Crusaders

When the Crusades came to Palestine at the end of the 11th century, Ashkelon was the last coastal city to fall. In 1153, after a seven-month siege, Crusaders took the city, ending five centuries of Muslim rule. The Muslim sultan Saladin retook Ashkelon in 1187, but when faced with certain defeat by a new wave of Crusaders in 1191, he destroyed the city rather than let it fall into enemy hands. Around 1240, as Crusaders rebuilt the city one last time, an English knight carved his crest over the Arabic script of a marble panel (left) erected in 1150 by Muslim rulers of the Fatimid dynasty. Remnants of a gold belt (right) found in Ashkelon's rubble recall the artistry of the Fatimid era.



there was probably more demand for women.

In A.D. 324, when the emperor Constantine officially recognized Christianity, a new morality spread to Palestine. Monasteries flourished near Ashkelon and throughout the region. Christian pilgrims began flocking to the Holy Land from Europe, disembarking at Ashkelon en route to Jerusalem. Ashkelon enjoyed a new boom based on the tourist economy and increased international demand for its fine wines. Amphorae from the city's Byzantine era have been found as far away as London.

But newcomers were about to change the face of Ashkelon once again. The armies of Islam began storming the Byzantine world in the seventh century, and in A.D. 640 the city surrendered to Muslim rule.

The transition shows clearly in a dig site called grid 23, where late one morning sweating excavators are uncovering an Islamic villa. "Last week we found the leg of a Roman statue that got smashed during the Islamic period," says Ross Voss, supervisor of this grid. "We also discovered three bowls with crosses stamped on them, so maybe this was a church or bishop's residence before the Muslims arrived."

The team is excited today because they have just lifted the flagstone floor laid down by the Muslims and uncovered the decorative black, white, and ocher tiles of a Byzantine mosaic.

Shortly after this wall was inscribed "Dominion is Allah's," Crusaders breached the city. Muslims had the last word in the seesawing battle for control, destroying Crusader fortifications in 1270. Now archaeologists have dominion in Ashkelon.

"The mosaic was trashed before the Muslims covered it," says Stager. Clearly the Islamic newcomers planned to make Ashkelon over, and they did it with style, as indicated by gold filigree jewelry and large villas appointed with statues and mosaic floors.

For more than 500 years Ashkelon shone under Islamic rule. Then, in the late 11th century, the Crusaders began their incursions into the Holy Land. During the 12th century Muslims of the Fatimid dynasty refortified Ashkelon's walls, using old Roman columns to reinforce the masonry, and building or reconstructing more than 50 mighty watchtowers.

ONE AFTERNOON Tracy Alsberg takes me to the site where one of those towers once rose. We cross a dry moat and gaze up at the slanting wall of carefully cut sandstone. She pulls back sandbags that protect an engraved stone embedded in the wall. Its decorative Arabic characters spell "*al-mulk li-llah*—Dominion is Allah's." The stone was probably placed in the wall during the rebuilding.

More significant is an engraved marble slab five feet long found smashed to pieces in the moat. The inscription on the slab describes the building of the tower and gives the date of its completion—March 2, 1150. The slab, now reassembled and on display in the Israel Museum, testifies to the devastation Ashkelon suffered during the Crusades.

Both Crusaders and Muslims regarded Ashkelon as vital to control of the eastern Mediterranean, and over the next 120 years the city often changed hands. In 1153 the Crusaders took the city for the first time after seven months of siege. They held it for 34 years before being driven out in 1187 by the Islamic commander Saladin. Four years later a new wave of Crusaders, led by Richard the Lion-Hearted, was advancing toward the city. With great sorrow Saladin decided to destroy the city himself. He feared Crusader naval power and wanted to deprive his enemies of a citadel they could use to launch marches toward Jerusalem or into Egypt.

"I would rather be bereaved of all my children than destroy a single stone of it," Saladin said, according to a contemporary writer.

Nevertheless, on September 12, 1191, he ordered his troops to begin tearing down the wall and towers. "Ashkelon was a town likable to the heart," reported the same writer. "The people were deeply saddened and wailed strongly because of the town's destruction, and because of their having to leave their homeland."

Saladin then ordered the city to be set on fire. By September 21 destruction was complete, and Saladin left Ashkelon.

Evidence of that destruction remains along Ashkelon's beach. Waves splash over large slabs of stone and Roman columns that Saladin's army pulled from the city's walls and used to block the harbor.

Despite Saladin's efforts, Richard the Lion-Hearted occupied the abandoned city in 1192, briefly restoring it as a fortress. Trying to erase the Islamic past, one Crusader later gouged his heraldic shields into the stones of the ancient city, including the marble slab that had been so elegantly inscribed to commemorate the building of the new watchtower in 1150. Moshe Sharon, an epigrapher at Hebrew University, has actually identified the desecrater—Sir Hugh Wake, an Englishman from Lincolnshire, who probably died at Ashkelon in 1241. Egypt's Mamluk rulers destroyed the city a final time in 1270. By then the Crusades were over, and the region had lost its strategic importance.

But Ashkelon is rising anew. A modern skyline of high-rises now soars behind the ruins. In the past decade throngs of newcomers, mostly Jewish immigrants from Russia and Ethiopia, have relocated to a reborn city.

"Today nearly 100,000 people live here," says Tracy Alsberg as we walk one evening along a new beachside promenade. Rock music blares, and crowds of boisterous young immigrants mingle with other Israelis in bars and cafés. There seem to be almost as many signs in Russian as in Hebrew.

Suddenly I realize that I have not been visiting a dead city at all. Ashkelon's tradition as a melting pot and emporium persists. These newcomers are creating their own unique culture at the dawn of this millennium as surely as the Philistines, Phoenicians, and Muslims did in past ages. The story of Ashkelon is still being written.

MORE ON OUR WEBSITE

Learn more about life in ancient Ashkelon and find related websites and other resources in More to Explore at **nationalgeographic.com/ngm/0101**.

IN DEEP WATER

A QUARTER MILE DOWN, BOB BALLARD DISCOVERS IRON AGE SHIPS LADEN WITH WINE JARS

When Bob Ballard discovered the *Titanic* in 1985, it was a great opportunity to learn more about—the *Titanic*. When he discovered two Phoenician ships in the Mediterranean in 1999, it struck him as another thing altogether: a window into the story of human civilization. They were the oldest deep-sea shipwrecks yet found, the first Iron Age ships found in the Mediterranean, and the earliest Phoenician ships found anywhere.

"These are great, great discoveries," says Ballard (above, in cap). "They're chapters of history we don't know much about."

From the surface ship the research team directs the ROV *Jason,* 1,200 feet down, to place 2,700-year-old Phoenician artifacts in a device that will lift them to the surface.

Rewind to the summer of 1997, when a U.S. Navy research submarine found what looked like shipwrecks 30 miles offshore from Ashkelon, at a depth of 1,200 feet. On the seafloor were hundreds of large storage jars called amphorae, arrayed roughly in the shape of a ship. Once ashore, the crew contacted Ballard and showed him the video footage they took, and Ballard in turn contacted Harvard

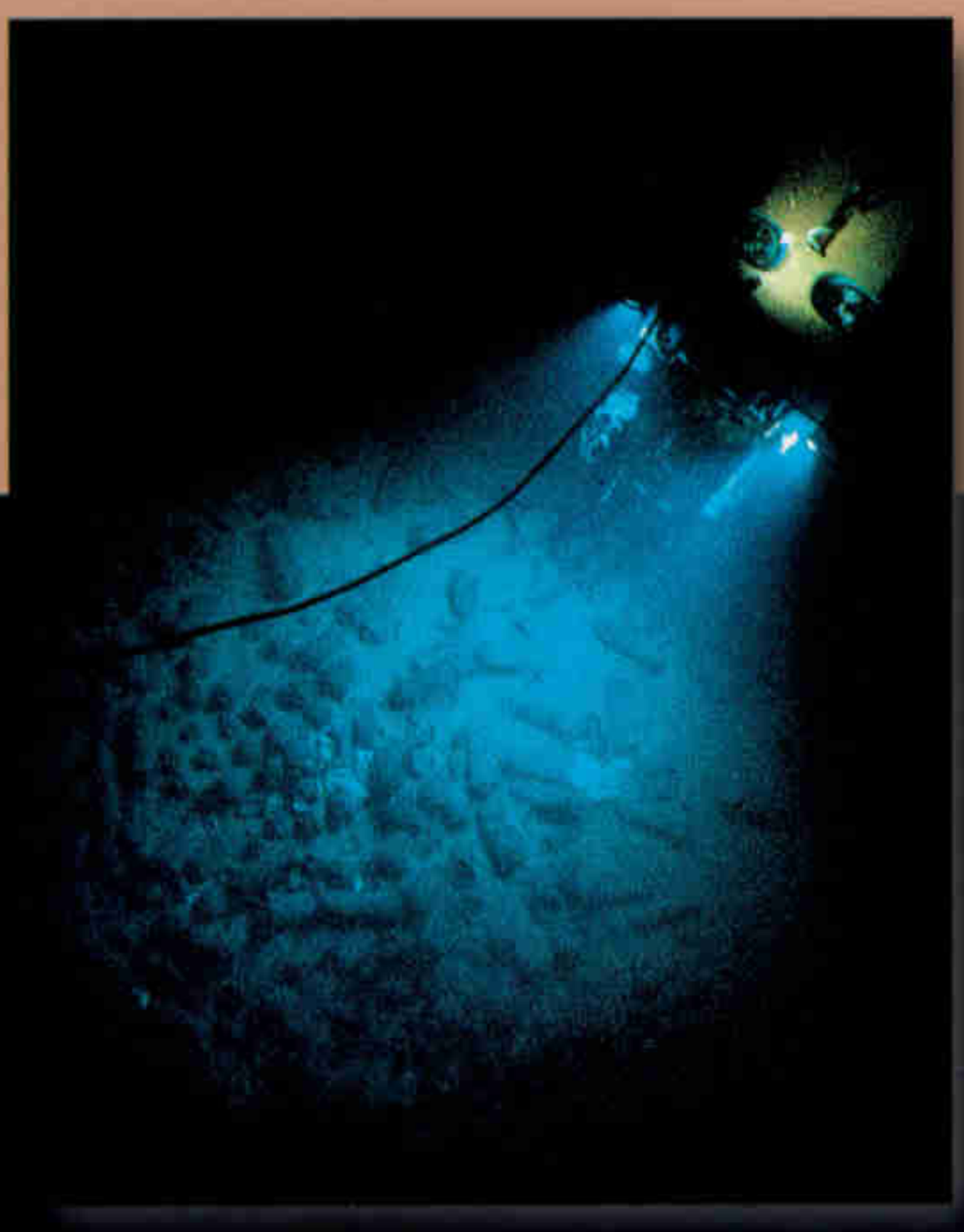
"WE DIDN'T EXPECT THEM TO BE IN

University archaeologist Lawrence Stager, an expert in ancient trade.

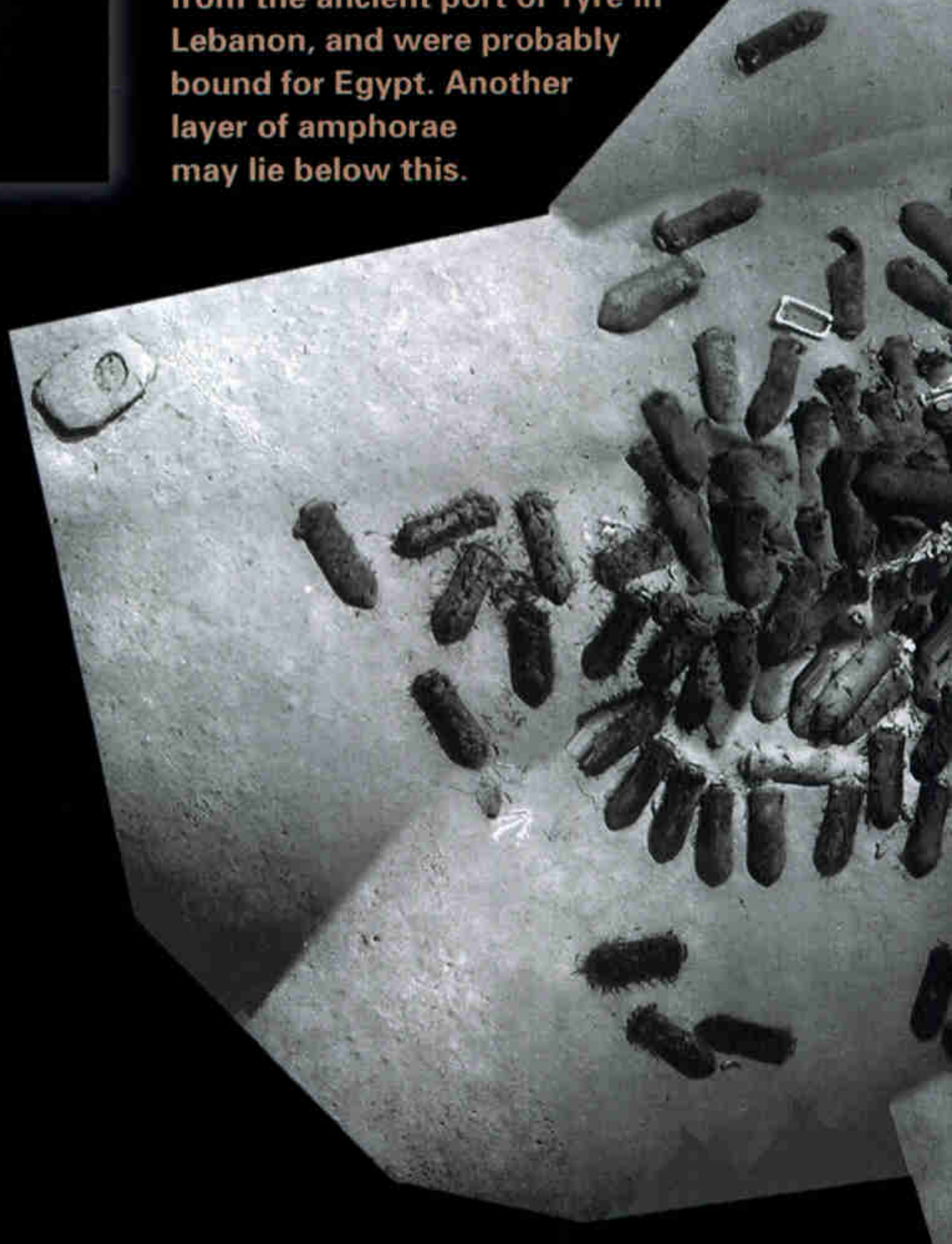
"We showed Larry the fuzzy videos, and he said, 'It's either going to be Byzantine, which is no big deal, or Iron Age, which is a *big* deal.'" Two years and a million dollars later, Ballard and Stager set sail on the 375-foot *Northern Horizon* with 55 tons of equipment to find out which it was. "We took a gamble," Ballard says.

Side-scan sonar located the wrecks, and the remote-controlled deepwater robot *Jason* was sent down to one of them. When the amphorae came into view, Ballard looked expectantly at Stager. Were they Byzantine jars or Phoenician? Stager lit up. They were the find of a lifetime. "It was more than a night to remember," Stager says. "It was ecstasy."

Why was Stager so excited? The Phoenicians were the greatest maritime merchants of the ancient world. They traded with Egyptians,



Photographed from a vehicle tethered above it, *Jason* hovers over one of two wrecks (left) and records more than 800 digital images that were then assembled into a composite (below). The ships were carrying wine from the ancient port of Tyre in Lebanon, and were probably bound for Egypt. Another layer of amphorae may lie below this.



SUCH WONDERFUL SHAPE." —BOB BALLARD

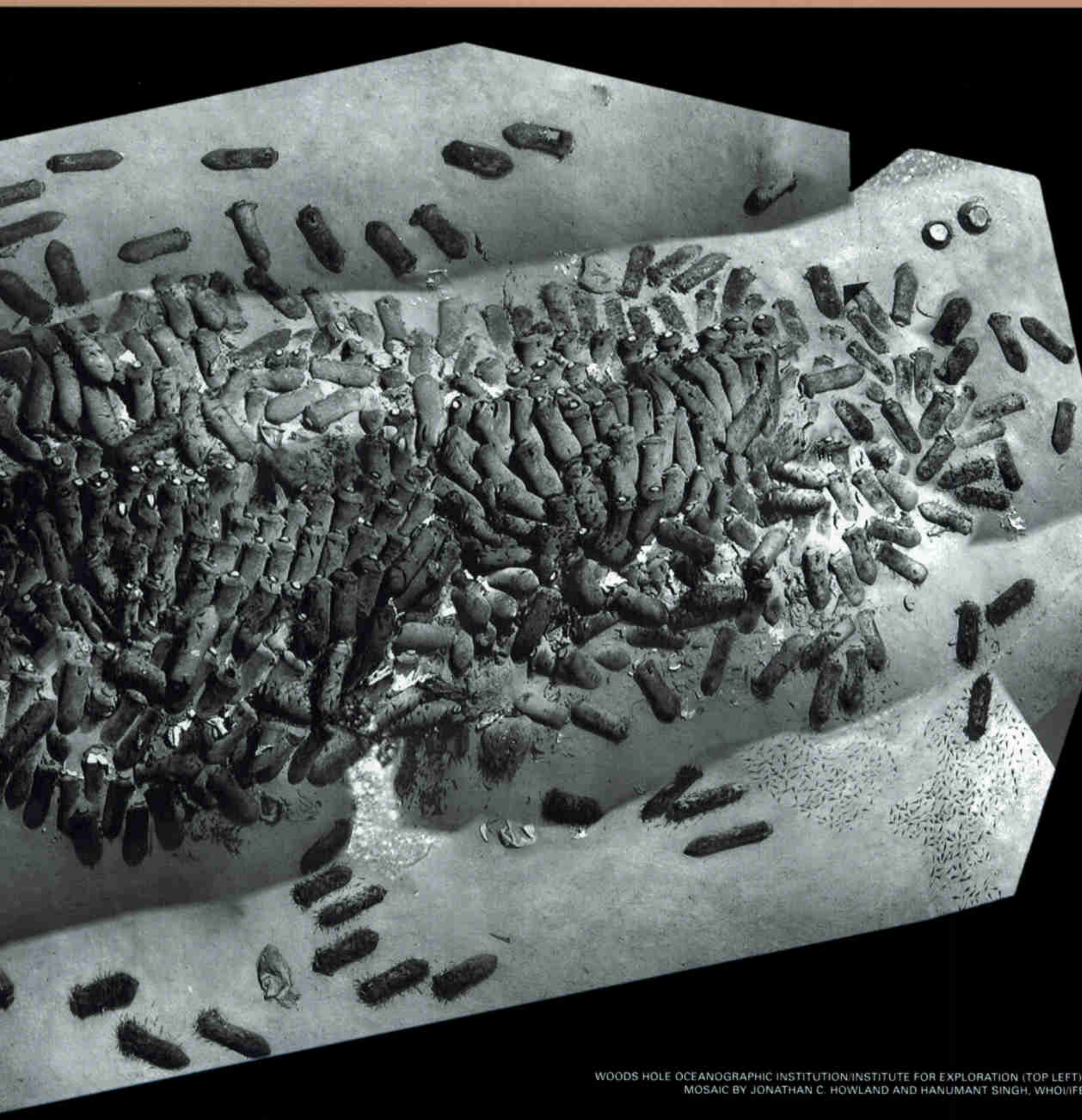
Greeks, and Philistines, and they made the first recorded circumnavigation of Africa. They supplied Solomon with lumber and engineering technology for his temple in Jerusalem, and their alphabet evolved into the Roman alphabet we use today. Yet we know very little about them.

These ships set sail around 725 B.C., about the time Homer is thought to have written the *Odyssey*. They each carried more than ten tons of wine. The larger of the two ships, about 60 feet long, carried upwards of 400 of the five-gallon jars, few of which were broken in the sinking. Ballard believes that the ships were caught by a storm.

When the ships hit the seafloor, a mile apart, they were buried up to their decks in the soft sediments. Wood-boring organisms ate the exposed upper parts, obliterating evidence that might have matched designs known from Assyrian carvings and shipbuilding materials described in the biblical Book of Ezekiel.

Over time the currents did their work, washing away the sediments that covered the amphorae and leaving the wrecks ripe for discovery.

Jason was able to retrieve some items for immediate study, but Ballard plans to return to the site in 2003 with a new ROV, named *Hercules,* capable of excavating the sites. □



WOODS HOLE OCEANOGRAPHIC INSTITUTION/INSTITUTE FOR EXPLORATION (TOP LEFT); MOSAIC BY JONATHAN C. HOWLAND AND HANUMANT SINGH, WHOI/IFE

JAPAN'S IMPERIAL PALACE

BEYOND THE MOAT

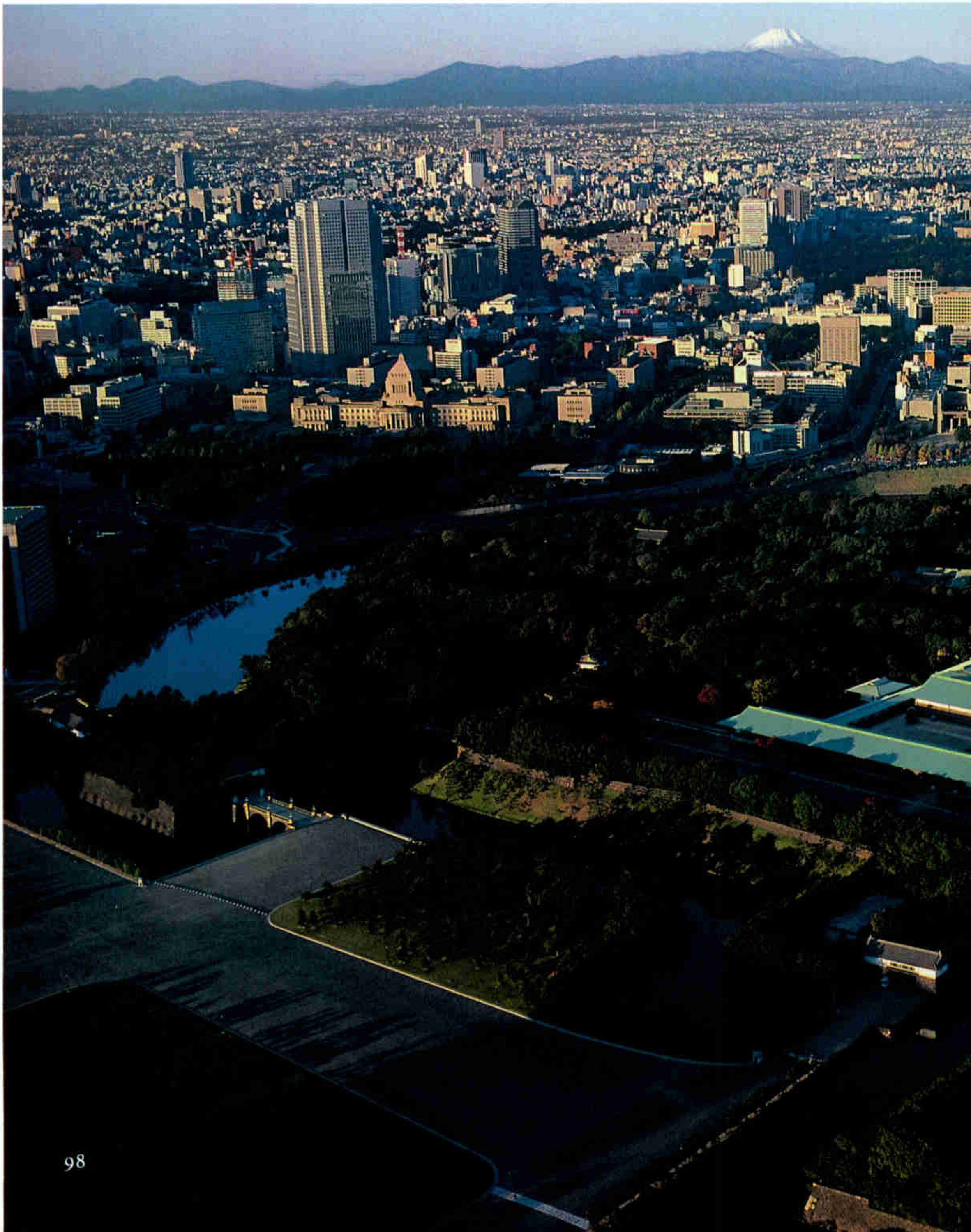
BY ROBERT M. POOLE EXECUTIVE EDITOR

PHOTOGRAPHS BY SAM ABELL

NATIONAL GEOGRAPHIC PHOTOGRAPHER

Watchtowers and tradition guard the main entrance (preceding page) to Japan's Imperial Palace, a 17th-century castle complex now home to Emperor Akihito. Guests in a spring mist attend the Emperor's garden party, which honors scientists, statesmen, and ordinary citizens doing the extraordinary.

Under distant Mount Fuji, Tokyo crowds against 284 acres of imperial grounds marked by old moats and deep woods. The broad, green-roofed palace, built in 1968, replaced one destroyed by fires spreading from Allied bombs in World War II.



BEFORE DUSK ON A JUNE EVENING Hideo Sugiyama finished some last minute gardening, looked at his watch, and disappeared to dress for work. Off came his V-neck sweater and corduroys, the soft loafers and Dunhill socks. On went a grass skirt, dark blue tunic, straw sandals, and soft cap pointed like a wizard's hat. A man who might have passed for a stockbroker had transformed into a figure from history, one I had seen in a painting from 17th-century Japan.

Like the man in the painting, Mr. Sugiyama was a cormorant fisherman, using wild birds he had trained to catch fish in the Nagara River. He was not just any cormorant fisherman, but fished for the Emperor of Japan, keeping him stocked with *ayu*, a seasonal delicacy from the sleepy city of Gifu. But the point of his job was not so much to feed Emperor Akihito as to sustain one of the oldest methods of fishing known to Japan, which dates from at least A.D. 701.

"One of the major roles of the imperial family is to preserve traditions like this one," said Ryuji Takahashi, manager of the Special Ceremonies Department of the Imperial Household Agency, the government unit that runs the palace and pays a small group of fishermen like Mr. Sugiyama. "It's not very economical, but it is an important part of our cultural history," he said.

Thus the link between Tokyo and faraway Gifu, which brings us back to Mr. Sugiyama, a civil servant in a grass skirt at the dawn of the 21st century, sitting cross-legged by the river, watching for darkness to fall.

"Time to go," said Mr. Sugiyama, motioning for photographer Sam Abell and me to follow him down the shore, where six long, narrow cormorant boats rocked in the current, yellow flames crackling in iron baskets at their upswept bows. As the boats sped downstream in the dark, the fires attracted fish, and teams of leashed cormorants—12 for each boat—swam out to catch them. Somehow, none of the leashes got tangled. Paper lanterns glowed along shore, where hundreds of tourists came to watch from dining barges. Spectators cheered as Mr. Sugiyama's little fleet swept past, throwing sparks. It was all over in a matter of minutes. The catch would be packed on ice, put on the next train, and rushed to Tokyo.

The ideal of *shibui*, or astringent beauty, lives alongside Western influences in South Garden. Volunteers tour the grounds before they start the day's weeding and raking. "It is an honor for us to be here," says one.

The fish were destined for the Imperial Palace, where Emperor Akihito, Japan's 125th monarch, lives and works in an imposing 17th-century castle complex that covers 284 acres of green at the heart of gray Tokyo. With its sprawling gardens, inky moats, and dazzling watchtowers, the palace lends a touch of old majesty to the rush of life in the capital.

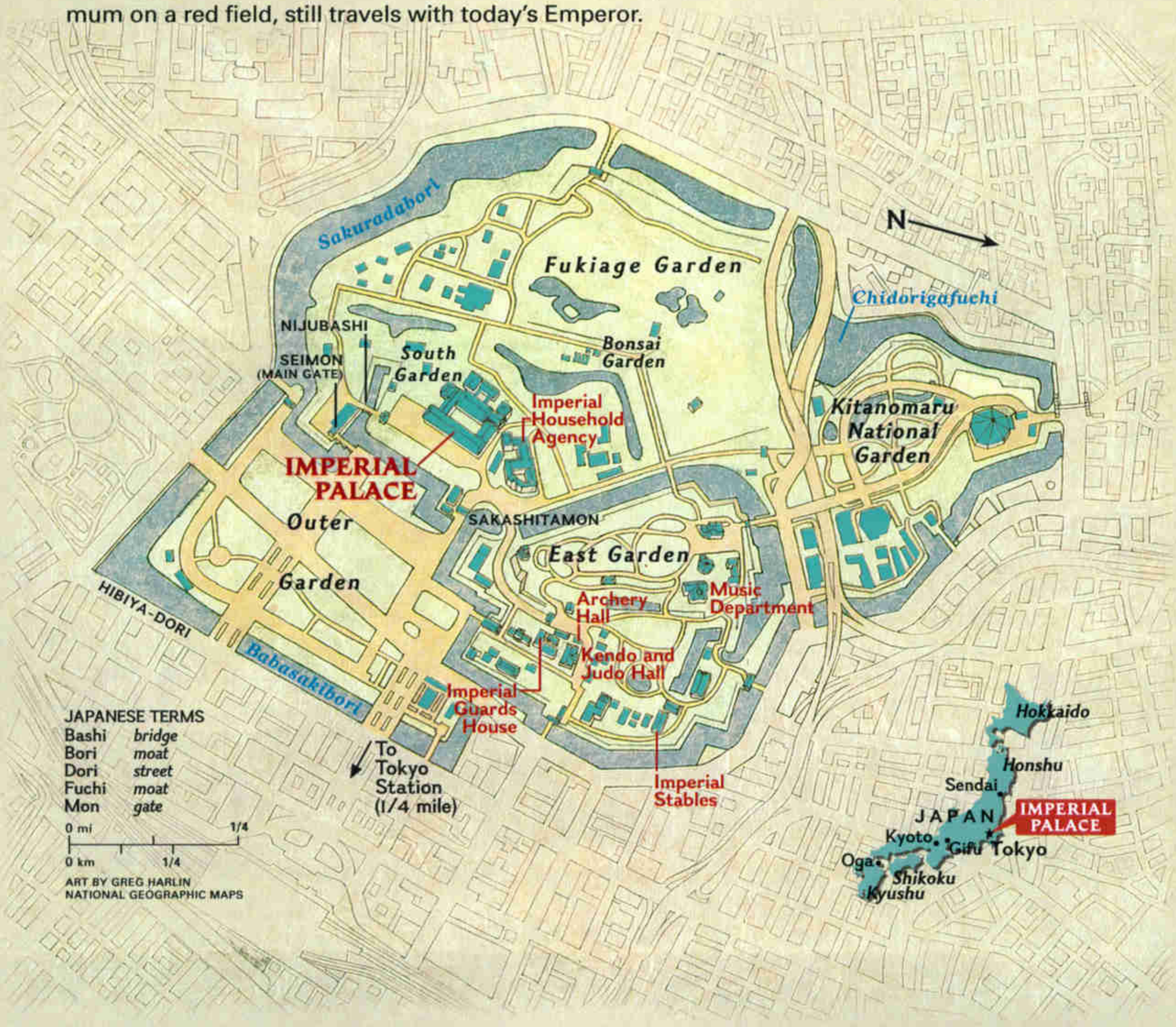
The palace is also a reminder of this culture's respect for tradition and of the ruling family's staying power, which reaches back at least 2,000 years in an unbroken line of Emperors and Empresses. That makes the family the longest reigning dynasty on Earth, symbolized by the chrysanthemum seal.

Although most of the inner castle has long since burned and crumbled, enough of the outer battlements remain to send a chill through visitors seeing them for the first time. And that, of course, is the intended effect. Until the Meiji Emperor moved from Kyoto and into Edo Castle in 1869, the complex was the fortress of Japan's legendary Tokugawa shoguns, who kept their rivals at bay through a combination of wit, intimidation, and brute force. Edo Castle was never attacked.

I understood why one morning, on a walk up Hibiya-dori, a major road that runs through Tokyo's Marunouchi district, where cars wheezed alongside an outer moat. At my

THE PALACE AT TOKYO'S CENTER

From the modest castle town of Edo (Mouth of the Estuary) grew modern Tokyo, now home to some 12 million people. Remnants of Edo Castle's moats and walls remain as reminders of the fortress shoguns built "unparalleled under heaven." Those feudal rulers yielded power in 1868 to the Meiji Emperor, who relocated Japan's capital from Kyoto and named his new city Tokyo (Eastern Capital). His standard, a gold chrysanthemum on a red field, still travels with today's Emperor.



back, traffic noises echoed off glass skyscrapers while commuters in their thousands poured from subway stops. Before me lay Babasaki Moat, deep and black, with a steep stone wall rising from the water on the other side; beyond that, another ring of moats, and more walls guarding the inner palace. It looked impenetrable, enough to wilt the toughest samurai.

An elite corps of Imperial Guards still patrols the gates, batons and shields at the ready. The inside is protected by the Imperial Household Agency, a bureaucracy with a very conservative reputation, which is why some Japanese speak of a "chrysanthemum curtain" shielding the inner palace.

MY ASSIGNMENT was to penetrate that curtain. I wanted to meet the small community of people—a thousand or so—who keep the palace running, who work behind the scenes to prepare for state banquets, who understand the value of court traditions such as cormorant fishing, New Year's poetry contests, and the intricacies of *gagaku,* traditional music performed by court musicians. And eventually I hoped to see the man at the center of this cryptic world, Emperor Akihito, son of the late Emperor Hirohito and symbol of the Japanese state.

With that ambitious agenda in hand, Sam Abell and I presented ourselves at the Sakashita Gate on a beautiful spring day. Willows danced in the breeze and swans cruised the moat, escorted by fat carp. We trudged up the stairs of the Imperial Household Agency and explained our mission to a palace official. He frowned. He fidgeted. He laughed outright at a couple of our requests, which involved seeing the Emperor at work. We showed him NATIONAL GEOGRAPHIC articles on the Vatican, Windsor Castle, the Kremlin. He skimmed them and put them down on the coffee table between us. "These are impressive," he said. "But it is no passport here." Sam and I traded worried glances. This was going to take some time.

Over the course of a year, we took small steps, faithfully crossing the moat, pressing court officials persistently but politely, keeping in mind the advice of Nob Okawara, Editor of NATIONAL GEOGRAPHIC in Japan.

"Don't be cowboys!" Nob admonished—his way of urging us not to be pushy Americans. We gradually found our way around the palace grounds, where azaleas were beginning to bloom, a spattering of pink against glossy leaves. We would see more, eventually meeting the Emperor and Empress one morning while they watched birds on the palace grounds. (See "Emperor Akihito, Man at the Center," page 120.)

When we reached the Imperial Stables, we ran into a wiry man in black boots, silver spurs, and a constant smile. Sumito Matsuzawa, the stable master, was checking over some horses assigned to carriage duty. They were Cleveland Bays of uniform size and color. "That is so they do not stand out," said Mr. Matsuzawa, who soon had me sitting in the back of an open carriage, being pulled through East Garden by a pair of horses on a practice run. "Any with white spots or other distinguishing features aren't brought in," he said, confirming a general impression that was beginning to form: Beyond the moat, the emphasis was on understatement, simplicity, blending in. Everyone, from the Emperor on down, avoided controversy or displays of ostentation, which extended to the horses clomping along in front of us.

"You can see that the horse on the right, Michisugi, has a temper," said Mr. Matsuzawa. "The one on the left, Michizaka, is the leader. He's calm. He covers for his friend. I know the personalities of each horse. They're like people that way."

This was daily routine for Mr. Matsuzawa and his horses, which figure prominently in one of the most distinctive palace rituals. When a new ambassador is posted to Japan, there is a ceremony at the Imperial Palace, where the emissary presents his credentials to the Emperor. By tradition, the Emperor provides transportation from Tokyo Station, the city's main train terminal. The ambassador can arrive at the palace by car. Or he can make his entrance in a lacquered horse carriage driven by a man in knee breeches and a plumed hat, with an escort of Imperial Guards on horseback. Guess which most of them choose?

"The carriage," said Thomas S. Foley, U.S. Ambassador to Japan. "They really go out of their way here to make things special."

Preparing for such occasions absorbed Mr. Matsuzawa, who drilled his horses so that they were used to traffic sounds and crowds. After weeks of such practice, the grand day arrived, May 27, 1999. New ambassadors from Italy

and Malawi would meet the Emperor today. Mr. Matsuzawa was up early, making sure the tack got blackened and the brass polished. The only problem was the wind, which howled through the city, making the kind of noise that spooks horses. It was the one thing Mr. Matsuzawa could not anticipate. His habitual smile was gone.

"Too much wind," he said, getting into his formal coat and mounting up. "No good!"

Sam and I dashed over to the courtyard in front of the palace to watch the first procession arrive. Over the sound of the wind we heard horses clattering across Nijubashi, a double bridge at the main entrance. The carriage

"WHEN OUR PLANTS ARE SHOWN AT THE EMPEROR'S GARDEN PARTY," SAID MR. IIZUKA, "I FEEL LIKE THEY ARE MY CHILDREN."

rolled up right on schedule and stopped at the front door. Horses and handlers looked fine, the ambassador from Italy less so. A tall man dressed in the requisite morning coat and striped pants, he had some difficulty unfolding from the silk-lined carriage. He wobbled on landing, just as the wind picked up a corner of the red carpet. But he regained his footing, received a warm greeting from the Grand Master of the Ceremonies, and disappeared into the palace.

I wanted to follow, but a court official steered me away from the building where the Emperor's most important public duties took place. "Sorry," he said. "Not even the Japanese press gets to cover these things. Very private."

There was plenty else to see—East Garden,

The years weigh heavy on imperial gardeners straining to transport a 250-year-old pine. The bonsai, one of 350 in the Emperor's collection, will greet guests visiting the palace for a state banquet.

for instance. I came to love that garden, tucked away in a corner of the palace grounds. Although the city's skyscrapers peeked over the edges, the garden was quiet and carefully tended, with shady paths and benches. You could sit and listen to the bees humming under the wisteria and watch the dragonflies hunting for food. The pond held koi fish, fat old con artists that rushed the footbridge for handouts when they saw a soft touch approaching.

The garden still served its purpose, as a place of restoration and contemplation. I often walked over on Sunday mornings to check on the progress of azaleas or to loiter on the zigzag bridge, which led through a field of irises just hitting their peak. They stood ankle deep in water, with blossoms showing lavender, white, blue, purple. Their placement was planned so that the Courageous Lion did not clash with the Boast of Edo, or the Monkey Dance with the Wet Crow.

This effort was not lost on the many iris fanciers who came to visit. They whispered appreciation and took pictures, moving with the light. A soft rain stole in, clouds smoking the sky. I took cover under trees at the garden's edge and heard distant music—somewhere the Imperial Guards were practicing waltzes for the forthcoming visit of Austria's president.

Their music was soon overpowered by crows, which swooped into the garden to shatter the calm. They acted as if they owned the place. Maybe they did. They came and went as they pleased, commenting on everything, strutting around the palace grounds. They turned out to be jungle crows, *Corvus macrorhynchos.* They woke up early, making a racket as they wheeled in the thin light over the palace, black against white towers. They even barged in on interviews I had with palace officials—months later I could still hear them on tape, arguing in the background.

"I've been listening to crows for so long I know what they are saying," said Fumio Iizuka, a mild-mannered man in glasses and shirtsleeves who oversees the Emperor's spectacular bonsai collection of about 350 trees. I joined Mr. Iizuka on his walk to work, along a shaded drive lined with cherries and maples, all screaming with crows.

"What are they saying now?"

"Here comes Iizuka! He's coming! He's coming! He's coming! They know me very well."

THERE WAS A DIFFERENT SENSE OF TIME HERE, ROOTED DEEP IN TRADITION.

Modern-day samurai clash bamboo swords in *kendo,* the fencing exercise Imperial Guards learn from Professor Koji Kato, at center. "We're not teaching these young men a sport," he says, "but a way of living, so they can withstand adversity."

"DON'T AIM," HE SAID. "JUST LET THE ARROW TAKE ITS COURSE."

Tsugihiro Osaki, a master archer who teaches *kyudo* to Imperial Guards, prepares his mind before facing the target. "You need tranquillity to do this," he says, "so that you can call on the inner force that makes the arrows fly." His fly straight to the target (above).

And he knows them, along with the other birds that flock to the palace grounds for refuge. The palace, like New York's Central Park, is a green island in a sea of concrete and therefore crucial for many of Japan's birds.

"About 65 species are here through a typical year," said Mr. Iizuka.

Many other plants and animals rely on the palace grounds, according to Mr. Iizuka and others involved in a major effort to identify all flora and fauna inside the moat. This census, encouraged by the Emperor and conducted by the National Science Museum, will provide a gauge for future environmental change.

"The crows are way out of balance," Mr. Iizuka said. "There are hundreds of them. They break up the other nests. It's like a Hitchcock movie. I have permission to shoot them."

"Any luck?" I asked.

"Not much," he said, smiling in admiration for a wily adversary. "They're awfully smart, you know."

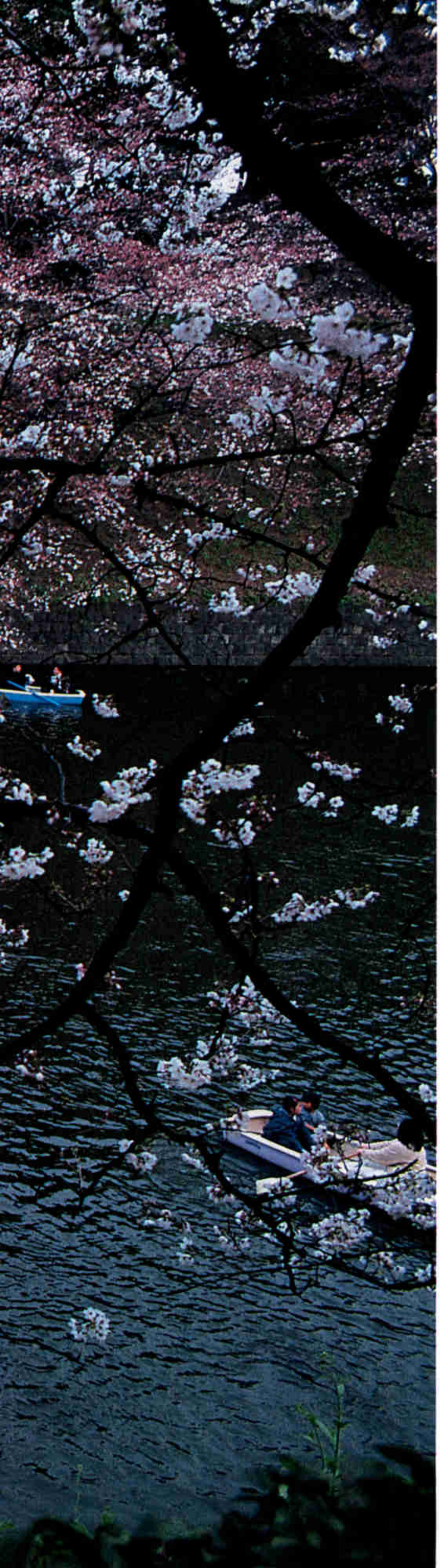
A network of monofilament lines stretched like a spider's web above Mr. Iizuka's bonsai garden to keep the crows from roosting in the plants. Centuries old, these trees had been lovingly tended to maintain their twisted shapes.

"You won't see the outcome of what we're doing to this branch for 20 years," said Mr. Iizuka, squinting at the raw limb of a red pine. "You have to be patient in this business."

As he talked, his hands never stopped picking at needles or leaves, reminding me of a mother absently smoothing her son's cowlick. We paused at the end of a row beside a 400-year-old pine, known as the Crab Tree. "It was originally shaped like a crab," said Mr. Iizuka, holding out his arms to demonstrate. "But, sorry to say, one of the branches died, so now it's a one-armed crab. It was quite a sight in its day," he said, sighing as if remembering an old love.

Here at the center of the palace grounds, walking among the years of carefully considered garden work, it was easy to forget that we were also at the center of Tokyo. A long-dead bonsai man tended that pine in the days when samurai roamed the land; another, that juniper before Portuguese landed ships at Kyushu; another, that maple when the Emperor was still considered a god. There was a different sense of time here, rooted deep in tradition. Nobody with a Palm Pilot and a production schedule

When cherry trees bloom along a palace moat, so do the citizens of Tokyo. They emerge from winter's doldrums to picnic under the trees and contemplate blossoms—reminders of *mujo*, the bittersweet impermanence of things.



was looking over Mr. Iizuka's shoulder.

"It's hard to find people who appreciate this relaxed approach to things," he said, stopping beside the garden's oldest resident, a 600-year-old juniper. "I get a lot of pleasure when our plants are shown at the Emperor's garden party. I feel like they are my children."

AFTER A FEW WEEKS in Japan, the stately pace of life inside the moat began to appeal to me, maybe a sign that I had been on assignment too long. There was time to walk the palace grounds and study the massive rough-hewn walls, made of stones brought here at great expense and effort from the provinces in the 1600s by the shogun's overlords. At a remnant of the old castle I brushed my hand across a block of blackened stone burned in the great fire of 1657—in those days a greater threat to Edo Castle than any invading army.

Inside the moat you were never far from Japan's involvement with history, a point driven home to me by Makoto Watanabe, Grand Chamberlain to His Majesty the Emperor. "In a place like this palace people tend to think in terms of thousands of years," said Mr. Watanabe, who probably spends more time with the Emperor than any other person, functioning as his private secretary and confidant.

Mr. Watanabe was a patient, likable gentleman, whom I came to admire. He worked out of an office tucked away in the back of the Imperial Household Agency. He had been an ambassador in a previous career and still looked the part. He was gracious. He was direct. He answered questions. He helped me make sense of an often baffling environment.

"Some of the media think that this is a very traditional, strange tribe who hide behind a chrysanthemum curtain just praying to god," he said. "And some think it's a very modern existence. Actually it's a combination of the two."

He explained how the Emperor spent his days, where he worked, how he occasionally played tennis. (His Majesty plays a steady game, anchored on the baseline, from which he doggedly returns each serve. "Deliberate and steady," said Mr. Watanabe. "A reflection of his personality.") He described how political power had shifted to and from the throne over the centuries, how the duties of the Grand Steward differed from those of the

Grand Master of the Ceremonies. He helped me understand the rigor of life inside the palace, where they did things by the book. The emphasis was on following ritual and honoring tradition—the prerequisites of success.

THIS BECAME obvious the day I visited Imperial Guards practicing *kyudo,* traditional archery with longbows. I slipped off my shoes, entered the *shajo,* or shooting hall, and bowed to greet a tall man with close-cropped hair and the gaunt look of a marathon runner. Tsugihiro Osaki wore a long black skirt and white shirt, typical dress for an archery master.

"Don't walk in front of these fellows!" said Mr. Osaki, breaking into a smile. Three similarly dressed men milled around the shooting hall, loosening up for their lesson. Mr. Osaki took his place behind a low table to the side and scrutinized students getting into position. They went through an elaborate ritual of preparation, completely focused on the process, as in a trance. Rain soaked the clipped green lawn of the *yamichi,* or arrow path, before them, which led to a whitewashed hut where three targets hung. Each of the archers took his turn, shooting arrows one after another. Mr. Osaki kept up a friendly commentary.

"Stand straight now," he told one.

"Your left shoulder's too low," he told another.

"Don't aim," he said. "Just let the arrow take its course."

Thwack! The arrow took its course, hitting the target 28 meters away.

"I see you can do it," said Mr. Osaki. "Good."

A few more arrows smacked home—to my Western mind a cause for celebration. But hitting the bull's-eye was secondary here. "You don't aim to hit the target in kyudo," said Mr. Osaki. "You get the posture right. You get the steps right. The arrow goes to the target of its own accord," he said, stabbing his index finger at an imaginary bull's-eye.

After class, I sat on the floor sipping green tea around a fire with Mr. Osaki and Kunio Matsui, a retired archery master who still comes back to help with classes. I asked how this kyudo training could possibly help Imperial Guards, none of whom I had seen carrying bows and arrows to work.

The older master answered: "We learn archery for concentration," said Mr. Matsui. "It builds confidence, a kind of mental awareness. We try to prevent things from happening. It's easier to anticipate trouble if you have sharpened your mental faculties."

Maybe it worked. When I asked Naotaka Kakuda, superintendent of the Imperial Guards, if his officers had ever had to defend an attack on the imperial family, he paused, looked at the ceiling for a few seconds, and answered: "No."

YOU MAY have noticed that most of the characters in this story are men. That is because most of the people working inside the moat are men, by long tradition. And that is why Takahiro Sono, the chief court musician, worried about the future.

"I'm afraid that the family tree is dying," said Mr. Sono, a lively man who is one of 25 musicians specializing in gagaku, music that came to Japan from China and Korea some 2,000 years ago. Still performed at official lunches, dinners, and public events, it is also integral to Shinto rituals in which Emperor Akihito participates.

"It takes about seven years of apprenticeship," said Mr. Sono, who has learned to play all of the gagaku by heart. "That's so we can play it in the pitch dark," when some of the court ceremonies take place.

Like most of the other musicians Mr. Sono was born to his job, following his father, grandfather, and a long line of Sono males who have performed for Emperors as far back as anyone can remember.

"My family has been doing this for 500 years, since they came from China," he said, showing me his place in a thick book that lists each ancestor who had served the court. "I have no son to take over for me."

"Any daughters?" I asked.

"I have three, but they cannot succeed me. It is the rule," he said without rancor.

I left Mr. Sono and his colleagues practicing gagaku for the Emperor's spring garden party. Their music echoed down the dark hallway, the shrill pipes and silk strings sounding like something made more for gods than for mortals. I felt sorry for Mr. Sono's predicament, but there was no hint that he felt sorry for himself. He did not complain. He did his duty, playing the part fate had assigned him. This reminded me of something Mr. Sugiyama, the cormorant

fisherman, said when asked whether he liked his job.

"It is not really a matter of like or dislike," he said matter-of-factly and looking me square in the eye. "It is my fate. I was born into it."

Like Mr. Sugiyama and Mr. Sono, Japanese of a certain generation viewed life this way, in terms of duty and fate. This code of behavior, grounded in Confucian tradition, extended to the Emperor himself.

"For all people who live in this society, there are roles to be played," said Empress Michiko, speaking to the press on the tenth anniversary of Emperor Akihito's enthronement. "The role expected to be played by us, members of the imperial family, is one of devoted moral support in contrast to the practical demands requested of an administrative system."

LIKE MOST OF THE OTHER MUSICIANS MR. SONO WAS BORN TO HIS JOB.

Court musicians in full silk dress march forth for an imperial garden party. The performers—officially recognized as "maintainers of a significant intangible cultural asset"—play *gagaku*, gracious music, imported from China and Korea 2,000 years ago.

This seemed pretty obscure—but, like other aspects of Japanese tradition, it bore up under scrutiny.

"In some ways it is a more reasonable system than we have in the United States," said a seasoned American student of government with experience on both sides of the Pacific. "Maybe we put too much responsibility on one person, the President. Here the responsibility is divided."

Under the Japanese constitution the Emperor focuses on symbolic acts aimed at preserving tradition and unifying the nation: He plants the first rice of the spring and harvests

the first of the autumn. He visits disaster areas and tries to comfort the disadvantaged. And he presents a cohesive Japan to the outside world, meeting with heads of state at home and abroad, a figure of continuity and calm in a volatile parliamentary system, which can change prime ministers the way some people change socks.

The Emperor has stayed out of politics, on the high moral ground. A professor of Japanese culture explained it in succinct terms: "What the people seek is an Emperor who is above the mundane world," said Yasuo Ohara, who teaches at Kokugakuin University in Tokyo. That reminded me of how recently—within 50 years—Japan's Emperor had been considered by some a living deity, above the clouds. The danger was that he could be so removed from daily life as to be irrelevant.

Footsteps pattern the frosty earth nourishing leeks at the Imperial Stock Farm. Under tight security, this 620-acre spread in suburban Tokyo produces milk, vegetables, and horses to exacting standards for the Imperial Palace.

"The Emperor means nothing to those of my generation," said a young businessman in Kyoto.

"A whole generation of youngsters doesn't know who the Emperor is," said a Japanese friend. "The palace needs to open up a bit more."

DESPITE SUCH TALK, Japanese support the imperial system overwhelmingly, according to national polls. Indeed some 50,000 people turned out in the rain and cold in November 1999 to celebrate the tenth anniversary of Emperor Akihito's reign—this despite the dreadful weather and a decade of recession that sent Japan tottering into the new century.

Hard times did not bother people like Junko Yamada, who came from Sendai to pay her respects on the Emperor's anniversary. "We've been through a lot together," said the 67-year-old housewife. "We're the same age."

Another admirer underscored the stabilizing influence of an Emperor as head of state. "This system provides stability in an uncertain world," said Yasuko Ikenobo, a member of the Japanese Diet who called my attention to trouble in other parts of Asia. "That doesn't happen here because the Emperor keeps things in balance. It's part of what makes us Japanese."

Representative Ikenobo took a sip of tea. "It may be wasteful to have this kind of system," she said. "But I would argue that this sort

Hideo Sugiyama, the Emperor's chief fisherman, feeds kindling into a basket on the Nagara River. The fires attract troutlike *ayu*, which are caught by leashed cormorants, then iced down and rushed fresh to Tokyo by train.

WITHOUT SAYING MUCH
AT ALL, THE EMPEROR
AND EMPRESS WORKED
A QUIET MAGIC.

In the village of Oga, Emperor Akihito and Empress Michiko step out to meet their subjects, a far cry from the days when Akihito's ancestors ruled "above the clouds." Japan's 125th Emperor is heir to the world's longest reigning monarchy.

of waste is useful. The same thing can be said of culture and art. Without them we cease to be human. We become robots. That is my frank opinion."

AFTER MONTHS of shuttling to and from Tokyo and prowling the Imperial Palace, I had managed a distant sighting of the Emperor but despaired of actually seeing him at work.

Then, without warning, the day came when Mr. Watanabe reached into his jacket, pulled out a calendar, and studied some pages.

"Would you be able to join us in a couple of weeks?" he asked. "Their Majesties are traveling to the island of Kyushu, where I expect they will receive a warm reception. It will give you a sense of how His Majesty works."

A few weeks later I was driving through the mountainous countryside of Oita Prefecture in Kyushu, where bamboo thickets and deep pine forests crowded the road, and all was laid in readiness for an imperial visit, Emperor Akihito's first, as monarch, to that region. Sidewalks were swept clean, flags handed out, flowerpots freshly planted, and gardens glistening in hillside villages where old ladies sunned themselves in chairs. Routine ground to a halt in little towns like Oga, where citizens lined the street across from the Toshiba store, arriving early to get a good spot on the curb.

"Have you met the Emperor before?" I asked a thin boy of about ten straddling his bicycle.

"Yes, yes, yes!" he answered in excited English, dancing around on his bike seat. Four or five chums pounced on this statement, scolding him for lying to a foreigner.

"No, no, no!" he said, still smiling.

Just then two stout white police motorcycles came purring up the hill, followed by a black Toyota sedan moving at a regal pace, a red flag snapping on its hood, a gold chrysanthemum on its door, and Their Majesties in back. The citizens of Oga waved their little flags, which made snapping sounds in an afternoon suddenly quiet. The Emperor and Empress drove by in slow motion, waving to the crowd, making eye contact through the open windows.

"He looked right at me!" said a woman.

"I saw him!" said another, who had waited for two hours and squatted down to half her height so she would be at eye-level with the Emperor and Empress. "Wasn't she beautiful?"

Before anyone could answer, the motorcade

had melted over the horizon and the spectators stood blinking in the bright April sun, as if wondering what to do next. One by one they drifted away, back to home, back to work, off to baseball practice. Their Majesties went on to the next stop, a Sony factory just around the corner. There disabled workers were housed, fed, and trained to make microphones for the famous electronics company.

"How is the quality?" the Emperor asked Nobuyoshi Kunimori, manager of quality control for the plant.

"Tell him it's good," interrupted Norio Ooga, then chairman of Sony.

"It's good," said Mr. Kunimori.

All along the factory line, workers laughed with their Emperor, who moved down the line with the Empress, asking after each worker's health, inquiring about the work, treating each as if he were the only person in the room.

"Don't your eyes get tired?" the Emperor asked a young man in a wheelchair. "It's not too bad," the worker answered, showing off a special pair of clippers he used to cut wires. "Well, please take care of your health," said the Emperor, moving on to meet the next worker.

"What's that you're making?"

"How long have you been working here?"

"How are you feeling today?"

Without saying much at all, the Emperor and Empress worked a quiet magic here, transforming an ordinary day into something special. Everyone seemed to be smiling, comparing notes, trading stories of the afternoon the Emperor came to town. Maybe some even forgot their problems for a while, basking in the presence of a couple whose job it was to make people feel better.

The Sony workers poured out of the factory, crowding the curb with wheelchairs to see the Emperor and Empress off. Then came the white motorcycles and the black car. People bowed deeply, a sign of respect for the family that had weathered centuries of change and turmoil. These subjects, like many other ordinary Japanese, seemed to take comfort in knowing the Emperor was there at the center, a symbol of compassion and stability in a nation where such things still matter.

MORE ON OUR WEBSITE

Listen to *gagaku*, the music of the imperial court, and learn more about this 2,000-year-old tradition at **nationalgeographic.com/ngm/0101**.

EMPEROR AKIHITO

MAN AT THE CENTER

Tenth anniversary of Emperor Akihito's enthronement, Tokyo

"You can gaze upon the lords,
but looking at the shogun will make you blind;
and the emperor cannot be seen at all."

—Old Japanese saying

Emperor Akihito is not invisible, as the old proverb suggests, but he is a modest man with an understated manner that seems to belie his position as *tenno,* or heavenly sovereign, of this modern and influential nation.

I met him on the eve of my departure from Japan, when he caught me by surprise on the palace grounds.

Sam Abell and I had been standing with a pack of press people watching the imperial couple and their daughter on their morning walk when, without warning, a chamberlain separated us from the others and invited us to follow. Then I heard the Emperor calling Sam's name. "Mr. Abell, how are you?" he asked, reaching out to shake hands instead of bowing. Emperor Akihito turned and held out his hand to me. Flustered, I took it, squeezed firmly, and mumbled a few words. The Emperor and Empress, smiling and relaxed, soon put me at ease, chatting as if they had all the time in the world, inquiring about our work, speaking warmly about NATIONAL GEOGRAPHIC. (See Behind the Scenes.) When we said our farewells, I tried to fix the impression in memory: His handshake was crisp and dry, his face open, his manner calming, his voice strong but not loud, with a hint of sandpaper about it. His dark eyes suggested good humor and a lively intelligence. He was compactly built and ruggedly handsome, grayed and slightly stooped by the years at age 67. The overwhelming impression was the aura he projected—one of kind concern.

He disappeared up the path and out of sight in the dark shade, headed for the day's

appointments. The work consists largely of ceremonial appearances, which often stretch into nights and weekends, and it is conducted under the unblinking eye of a public poised to notice the slightest misstep.

Not that Emperor Akihito makes many mistakes. When delivering official remarks, he reads a speech word for word, seldom looking up from a text he has usually reworked in his own hand. He does a lot of rewriting.

He is careful and deliberate, which may reflect the twin influences of genetics and scientific training. Like his father, Emperor Hirohito, the current ruler is an accomplished scientist. An ichthyologist, Emperor Akihito specializes in gobies, a small kind of fish found in the moats of the Imperial Palace, along the shores of Japan, and in the coral reefs of the world. He has published papers in scientific journals, corresponds with fish specialists around the globe, and attends technical conferences whenever possible. "Research on the gobies is almost his only hobby," according to an associate.

The Emperor's particular interest in natural history is demonstrated each day, which usually begins with a long walk of botanizing or bird-watching in Fukiage Garden, the deep woods of the Imperial Palace. Here he has asked that gardeners allow the dandelions and other native plants to thrive in a natural state, in unkempt contrast to the vigilantly sculpted gardens elsewhere on the palace grounds. On these morning walks

The Emperor and Empress, their daughter, Princess Sayako, and ornithologist Ryozo Kakizawa, palace grounds

he is surrounded by nature in the raw, where hawks hunt crows in the trees and egrets stalk fish around the marshes.

Those who know the Emperor say he is familiar with the scientific names of most of the flora and fauna on the palace grounds. His concern for the natural world extends beyond the moat, where he speaks frequently on environmental issues, reminding listeners in Japan to value their forested mountains and pure rivers and encouraging foreigners to cooperate on global environmental matters.

"He speaks often about biodiversity," according to a senior court official. "In his mind a good environment is very important to human happiness. And he has made a connection between environmental concerns and world peace. There must be peace that will enable people to work together to maintain and improve the environment."

As a boy who knew nothing but war, Emperor Akihito has set out to be a man of peace. He tries to promote international understanding, projecting Japan's image as a nation that has devoutly avoided conflict since World War II, constrained by a postwar constitution that denies the nation a standing army and prohibits war as a policy of state.

"The war and the period after it weigh heavy on the Emperor's mind," according to an official who knows him. "He is mindful of those who suffered in the war, and he tries to console them by visiting places like Hiroshima, Nagasaki, and Okinawa."

Reforms imposed in the aftermath of World War II have made the heavenly sovereign a *shocho tenno,* or symbol Emperor, something less than the god his predecessors were thought to be. While Emperor Hirohito could appoint and dismiss cabinet ministers, generals, and other government officials, his son is limited to symbolic acts. This change actually returns to an arrangement that has obtained through the long march of Japanese history, with the exception of a few hundred years. Seldom did the Emperor have much power in the past, but stood as a figurehead in whose name military leaders and ministers ruled, citing the Emperor's imperial virtue as the source of their own authority. So it is in this indirect way that Emperor Akihito reigns, as most of his ancestors did, removed from the most onerous chores—making war, running the bureaucracy, engaging in politics.

This is not to suggest that Emperor Akihito leads a cloistered existence, stuck in a world where time stands frozen. Quite the contrary, he is a modern man who combines the best of the new and the traditional—for instance, writing out court poetry with a calligraphy brush but using his laptop computer to write and edit speeches. He reads avidly about current events and surrounds himself with seasoned advisers on world affairs, science, and technology, as well as key domestic issues. Career bureaucrats from different ministries in the government, including Japan's respected Foreign Ministry, occupy key positions in the Imperial Household Agency, giving a modern outlook to a bureaucracy previously known as the most hidebound of institutions.

Emperor Akihito is undoubtedly the most internationalist monarch his country has known. He travels each year to promote friendship among nations, having visited 16 countries since assuming the throne in 1989 and 37 countries before that as Crown Prince.

Emperor Akihito always travels with Empress Michiko, a gracious woman with a direct gaze, a kindly manner, and a refined style. She helps keep alive certain traditions within the court, especially silkworm cultivation and gagaku music, and has a keen interest in promoting children's literature.

The Emperor and Empress have three children—Crown Prince Naruhito, Prince Akishino, and Princess Sayako. Because the succession in Japan goes through the male line, by law Crown Prince Naruhito will succeed his father. After Naruhito, there is no successor, a matter of concern since 1993, when he married Masako Owada, a Harvard-educated diplomat who remains a favorite of the Japanese public. She and Crown Prince Naruhito have yet to produce an heir.

"We will trust the stork," says Crown Prince Naruhito, trying to deflect the pressure from a public whose interest in imperial matters never seems to wane, despite having lived with Emperors for hundreds of years. □

QUARTZSITE, ARIZONA

America's Larg

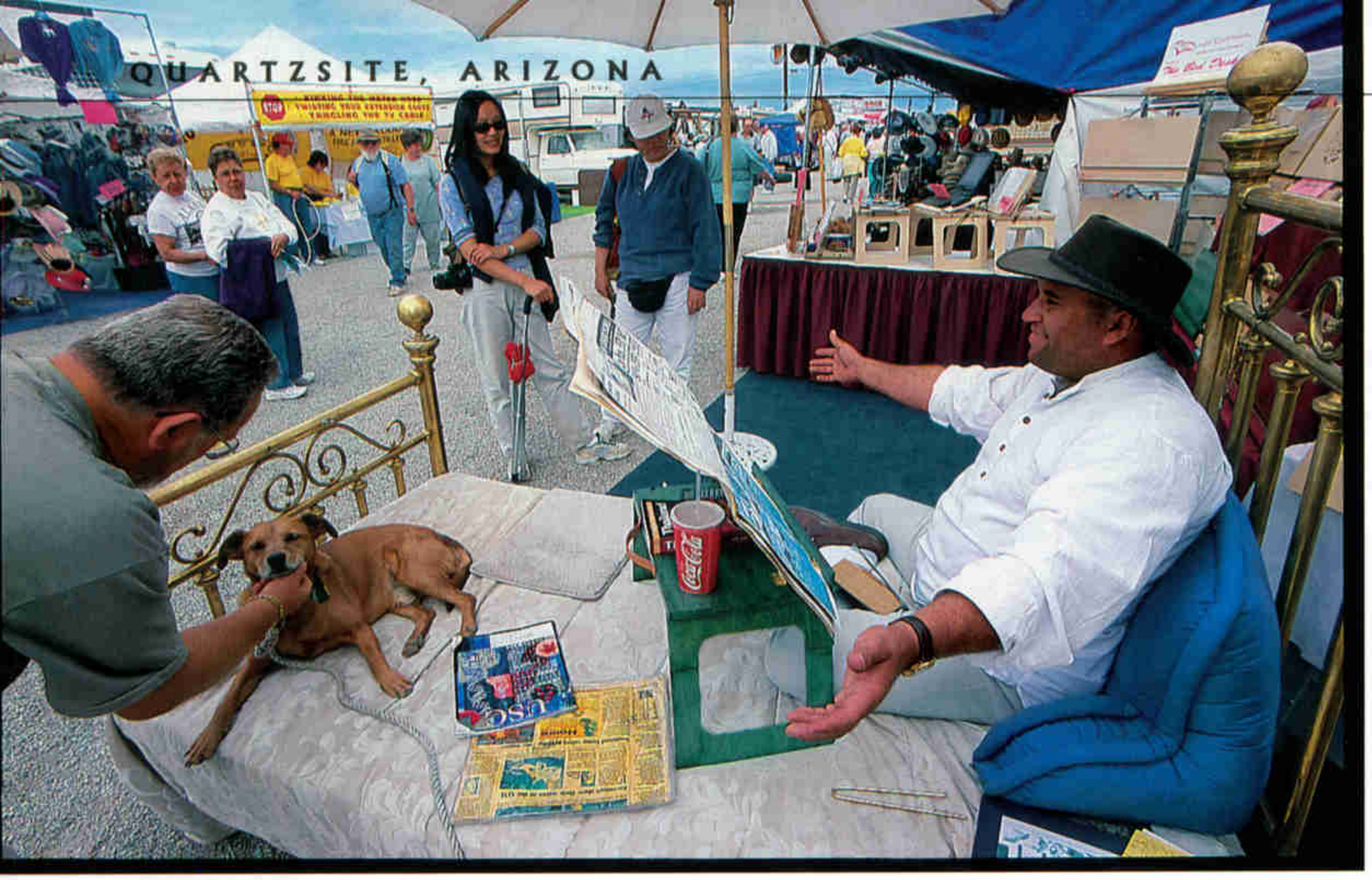
ARTICLE AND PHOTOGRAPHS BY CARY WOLINSKY

The town's not quite dead but is doing its damnedest to look that way. The mid-July temperature is a solid 118. Shops on Main are boarded up. An amber wind lifts tattered flyers over flat roofs and out to the desert. Humming "swamp coolers" strain to refrigerate a few of the 2,300 residents, who

est Parking Lot

853346

January 25, 2000



A vendor hawks lap desks along the 2.2 miles of stalls at Tyson Wells Sell-A-Rama.

wait for winter. Eight months a year Quartzsite, Arizona, isn't much more than a vast empty RV park, rectangles of dusty land gridded by neatly spaced wooden posts.

Then, like a mob of chattering starlings settling into a too-small tree, the snowbirds start landing in November. By mid-January, the mechanical car counter at the Interstate 10 exit is ticking off 26,000 vehicles a day. Within weeks 175,000 RVs cram inches apart into 79 trailer parks, onto front yards, and spill out seven miles on either side of town. Every year more than a million people reset their internal navigation and drive from Everywhere, North America, to this western Arizona dot on the map. Luxury motor homes, fifth wheels, cab-over campers, trailers, and converted school buses plunk down on the same patch of land.

"You haven't had the full RV experience until you've been to Quartzsite in January," says Phyllis Frey, of Livingston, Texas. She and husband Ron have been traveling full-time in their RV for three years. "It's a sort of pilgrimage," she says.

What's the attraction? Without exception every Canadian and Minnesotan RVer answers, "It beats shoveling snow." I hear this line from RV club members wearing "Hi My Name Is" badges while shoveling tons of rocks and gravel into machines vibrating at ear-splitting decibels, hoping to sift out a fleck of gold in this old mining town. Bud Neale, who runs the Pro-Mack South mining-supply shop, nudges me, saying, "Pretty good, me getting these retired execs to come out and work my claim for me." Bud charges ten dollars a head for the three-hour course.

"It's cheap!" Merv Boyd says on hearing complaints about the price of renting space in the 11,400-acre Bureau of Land Management (BLM) campground he supervises. "A hundred bucks for seven months, and they're all dry camping." Dry camping, or boondocking, means the vehicle is self-contained—power, water, waste collection, the works—needing only occasional hookups to pump out waste and take on water.

FULL-TIME POPULATION: 2,300

WINTER PEAK: More than a million

NUMBER OF TRUCK STOPS: Four

NUMBER OF BANKS: None

LENGTH OF LINE AT THE POST OFFICE IN JANUARY: Two blocks

FAMOUS NATIVE SON: Actor Buck Conner of silent-film Westerns. He's buried in a small cemetery behind the Chinese food restaurant.

FAMOUS ATTRACTION: Monument to Hadji Ali (known locally as Hi Jolly), a Syrian camel driver brought to Quartzsite in the 1850s to help the U.S. Army train a camel-mounted cavalry

Neon cowboy T. C. Thorstenson pitches his buffalo act to RVers.

"You haven't had the full RV experience until you've been to Quartzsite in January. It's a sort of pilgrimage."

"The BLM sunk an 800-foot well to alleviate the water shortage and installed waste-dumping stations," Boyd says. "We train a hundred volunteers to greet RVers and help the Quartzsite police find relatives when word comes of a distant crisis. These services are costly."

Irma Ruth (her e-mail name is "roaminirm") thinks boondocking should be free. "When I first went to Quartzsite in '89, people camped in the desert. The BLM didn't charge anything. Most full-time RVers [perhaps 1.5 million in the U.S.] are retired folks with limited incomes."

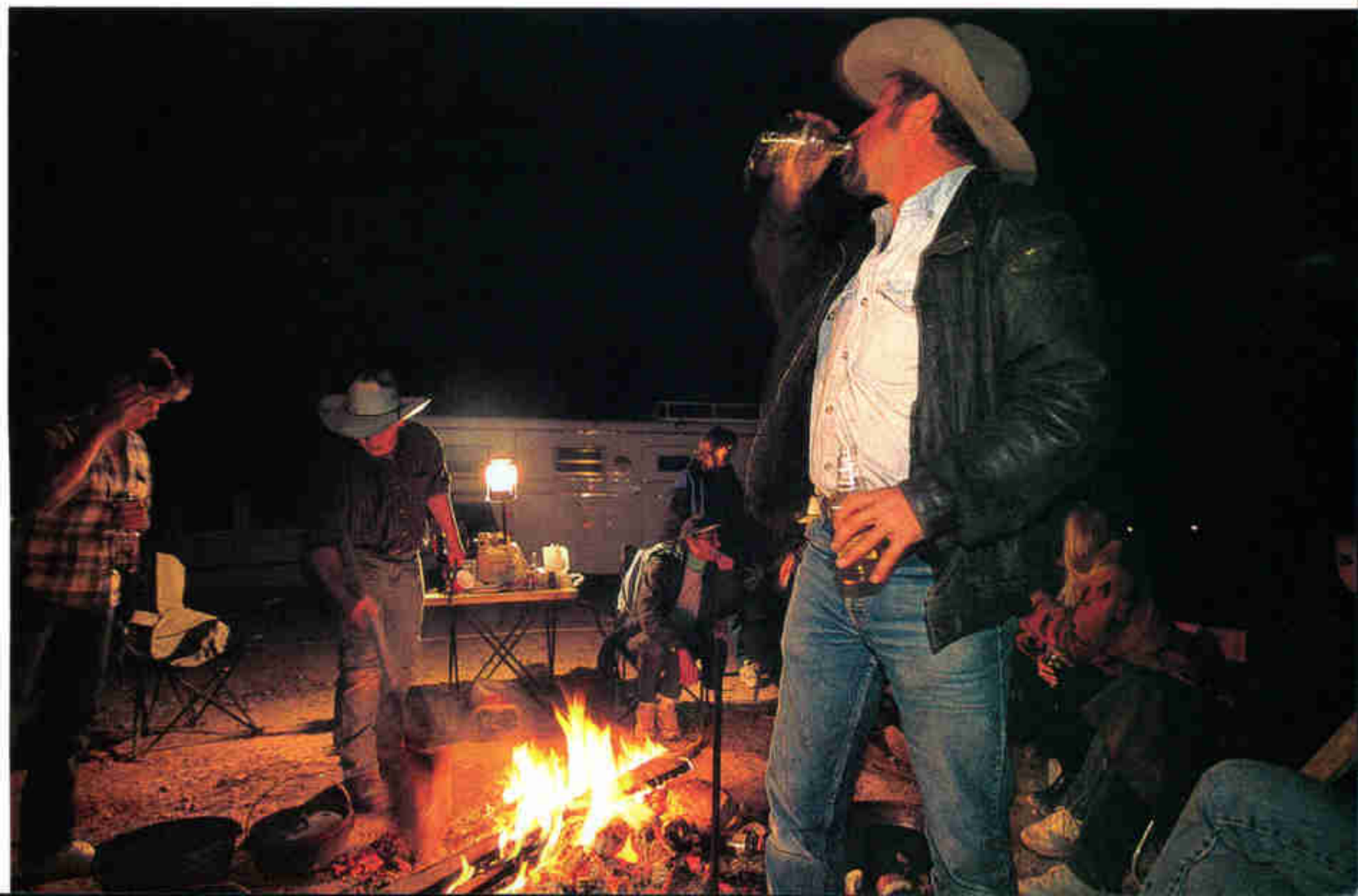
Before the seventysomething Irma started roaming America, she was an officer in an energy company in Pittsfield, Massachusetts. After retiring, she lived close to her grandchildren until her daughter said, "Mom, it's time you go out and play with kids your own age." So she hitched her Civic to the back of a 35-foot motor home and drove off. "I discovered that you just point the front end and the back end pretty much follows.

"The hardest thing about full-timin' is giving up your stuff," Irma says. She gave most of that to her granddaughter, who had a new house but nothing in it. "She gets a furnished house," Irma says. "I get to visit my paintings."

Irma's sentiments on stuff are hard to square with Quartzsite's main attraction: "Shop, shop, shop, till you drop," she says. In January Quartzsite fills with vendors selling pretty much anything, from chain saw sculpture and cow skulls to painted feathers and plastic snakes.

"If it's been made, it's been sold in Quartzsite," says Marilyn Armstrong, who with her former husband runs the Main Event, the largest (600 vendors) of the town's 18 swap meets. In the late '70s, they set up a food stand, selling to rock hounds prospecting for gold and other minerals in nearby hills. Searching for permanent space in 1981, they

Campfire camaraderie flares up once Quartzsite shops shut down.



spotted a land-for-sale sign that was so sun bleached they thought they were buying 10.5 acres. It turned out to be 105. "There was nothing here but saguaros and sagebrush," she remembers.

These days it's hard to find geodes and crystals in the acres of booths. The aisles are so packed with shoppers that even T. C. Thorstenson, a cowboy promoting his show, has trouble getting noticed. He is dressed in hot pink, astride a 3,000-pound buffalo.

A million guests a year is a strain for little Quartzsite, but thanks to local politics the town's infrastructure won't be upgraded anytime soon. "Every election has a recall," says one resident. "A handful of citizens can sign a petition and force a new election. We tried to put in an airport. The faction against it recalled the officials who wanted it. No airport. Same thing with sewers. There's a bit of Wild West left in us."

Len Pigg, a vice president of the Family Motor Coach Association, gets frustrated. "There's no bank, long lines at restaurants, grocery stores, and the post office, and a 45-minute wait to get through town," he says. "One visit is enough."

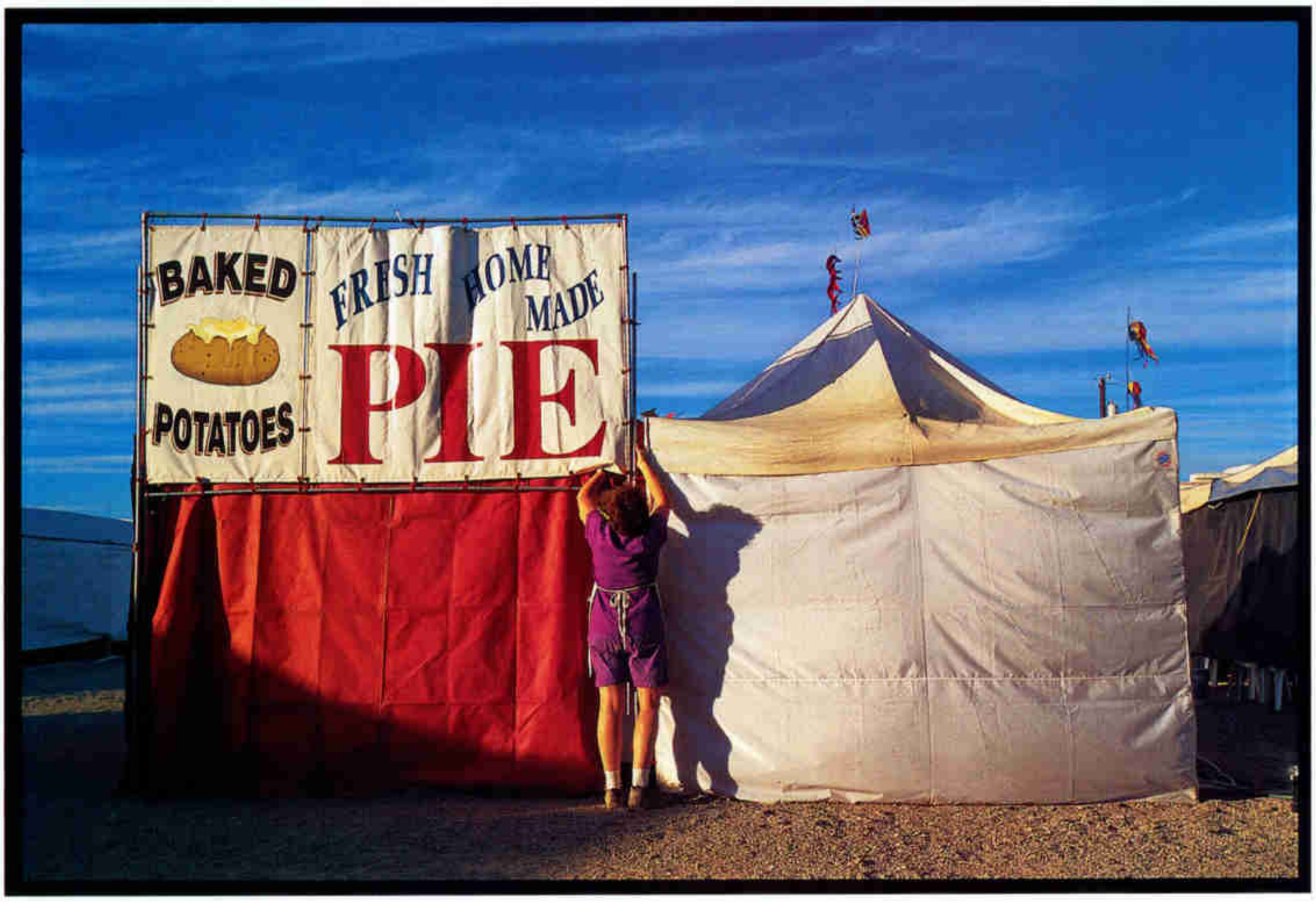
"Most come back," counters Steve Hardies, of Hardies Beads and Jewelry. "Maybe not right away. But sooner or later you're coming. There's something in those hills around town that's like a big magnet."

Roaminirm understands. "The weather and shopping aren't the only reasons people love Quartzsite," she wrote in a recent e-mail. "The boondockers enjoy peace and quiet—early morning walks among the cactuses and creosote bushes, listening for the occasional cactus wren, watching the setting sun sculpt the shapes of the mountains, and stargazing. Did you see how many stars were in that sky?" □

MORE INFORMATION

ON OUR WEBSITE There's more on 85346 at **nationalgeographic.com/ngm/0101.** **NOMINATE YOUR FAVORITE ZIP CODE** at **nationalgeographic.com/ngm/zipcode,** or mail your suggestion to PO Box 96095, Washington, DC 20090-6095. E-mail: **zip@nationalgeographic.com**

The Ames family sells 150 pies a day. Their biggest hit: rhubarb.



For people with Acid Reflux Disease

It's time to check your tummy out of the Heartburn Hotel.

Complete 24-hour heartburn relief is possible. Ask your doctor about Prevacid.

If you're suffering from persistent heartburn two or more days a week, even though you've treated it and changed your diet, it could be a sign of Acid Reflux Disease.

- Prevacid is a prescription medicine that can mean complete day and night relief from heartburn associated with Acid Reflux Disease. Individual results may vary.
- Once-a-day Prevacid works in a different way than over-the-counter heartburn remedies. Prevacid turns off tiny pumps that produce acid in your stomach.

Tiny pumps produce acid in your stomach.

Prevacid turns many of these pumps off.

- Millions of prescriptions have been written for Prevacid.
- Prevacid has a low occurrence of side effects, such as diarrhea (3.6%), abdominal pain (1.8%) and nausea (1.4%).

Ask your doctor for more information about Prevacid and if it's right for you. Find out how 24-hour Prevacid can help you and your tummy check out of the Heartburn Hotel.

For a free information kit call 1-888-607-ACID

PREVACID®

LANSOPRAZOLE 15-mg and 30-mg capsules

Leave your heartburn behind

www.prevacid.com

Please see next page for additional important information.

Brief Summary of Prescribing Information
(Nos. 1541, 3046)
03-5036-R14-Brf., Rev. March, 2000

PREVACID®

(prē-va-sid)
(lansoprazole)
Delayed-Release Capsules

INDICATIONS AND USAGE

PREVACID Delayed-Release Capsules are indicated for: 1. Short-Term Treatment of Active Duodenal Ulcer 2. *H. pylori* Eradication to Reduce the Risk of Duodenal Ulcer Recurrence 3. Maintenance of Healed Duodenal Ulcers 4. Short-Term Treatment of Active Benign Gastric Ulcer 5. Treatment of Heartburn and Other Symptoms Associated With GERD (Gastroesophageal Reflux Disease) 6. Short-Term Treatment of Erosive Esophagitis 7. Maintenance of Healing of Erosive Esophagitis 8. Pathological Hypersecretory Conditions Including Zollinger-Ellison Syndrome.

CONTRAINDICATIONS

PREVACID Delayed-Release Capsules are contraindicated in patients with known hypersensitivity to any component of the formulation.

Amoxicillin is contraindicated in patients with a known hypersensitivity to any penicillin. (Please refer to full prescribing information for amoxicillin before prescribing.)

Clarithromycin is contraindicated in patients with a known hypersensitivity to any macrolide antibiotic, and in patients receiving terfenadine therapy who have preexisting cardiac abnormalities or electrolyte disturbances. (Please refer to full prescribing information for clarithromycin before prescribing.)

WARNINGS

CLARITHROMYCIN SHOULD NOT BE USED IN PREGNANT WOMEN EXCEPT IN CLINICAL CIRCUMSTANCES WHERE NO ALTERNATIVE THERAPY IS APPROPRIATE. IF PREGNANCY OCCURS WHILE TAKING CLARITHROMYCIN, THE PATIENT SHOULD BE APPRISED OF THE POTENTIAL HAZARD TO THE FETUS. (SEE **WARNINGS** IN PRESCRIBING INFORMATION FOR CLARITHROMYCIN.)

Pseudomembranous colitis has been reported with nearly all antibacterial agents, including clarithromycin and amoxicillin, and may range in severity from mild to life threatening. Therefore, it is important to consider this diagnosis in patients who present with diarrhea subsequent to the administration of antibacterial agents.

Treatment with antibacterial agents alters the normal flora of the colon and may permit overgrowth of clostridia. Studies indicate that a toxin produced by *Clostridium difficile* is a primary cause of "antibiotic-associated colitis".

After the diagnosis of pseudomembranous colitis has been established, therapeutic measures should be initiated. Mild cases of pseudomembranous colitis usually respond to discontinuation of the drug alone. In moderate to severe cases, consideration should be given to management with fluids and electrolytes, protein supplementation, and treatment with an antibacterial drug clinically effective against *Clostridium difficile* colitis.

Serious and occasionally fatal hypersensitivity (anaphylactic) reactions have been reported in patients on penicillin therapy. These reactions are more apt to occur in individuals with a history of penicillin hypersensitivity and/or a history of sensitivity to multiple allergens.

There have been well documented reports of individuals with a history of penicillin hypersensitivity reactions who have experienced severe hypersensitivity reactions when treated with a cephalosporin. Before initiating therapy with any penicillin, careful inquiry should be made concerning previous hypersensitivity reactions to penicillins, cephalosporins, and other allergens. If an allergic reaction occurs, amoxicillin should be discontinued and the appropriate therapy instituted.

SERIOUS ANAPHYLACTIC REACTIONS REQUIRE IMMEDIATE EMERGENCY TREATMENT WITH EPINEPHRINE, OXYGEN, INTRAVENOUS STEROIDS, AND AIRWAY MANAGEMENT, INCLUDING INTUBATION, SHOULD ALSO BE ADMINISTERED AS INDICATED.

PRECAUTIONS

General

Symptomatic response to therapy with lansoprazole does not preclude the presence of gastric malignancy.

Information for Patients

PREVACID Delayed-Release Capsules should be taken before eating.

Alternative Administration Options

For patients who have difficulty swallowing capsules, PREVACID Delayed-Release Capsules can be opened, and the intact granules contained within can be sprinkled on one tablespoon of either applesauce, ENSURE® pudding, cottage cheese, yogurt, or strained pears and swallowed immediately. The granules should not be chewed or crushed. Alternatively, PREVACID Delayed-Release Capsules may be emptied into a small volume of either orange juice or tomato juice (60 mL – approximately 2 ounces), mixed briefly and swallowed immediately. To insure complete delivery of the dose, the glass should be rinsed with two or more volumes of juice and the contents swallowed immediately. The granules have also been shown *in vitro* to remain intact when exposed to apple, cranberry, grape, orange, pineapple, prune, tomato, and V-8® vegetable juice and stored for up to 30 minutes.

For patients who have a nasogastric tube in place, PREVACID Delayed-Release Capsules can be opened and the intact granules mixed in 40 mL of apple juice and injected through the nasogastric tube into the stomach. After administering the granules, the nasogastric tube should be flushed with additional apple juice to clear the tube.

Drug Interactions

Lansoprazole is metabolized through the cytochrome P_{450} system, specifically through the CYP3A and CYP2C19 isozymes. Studies have shown that lansoprazole does not have clinically significant interactions with other drugs metabolized by the cytochrome P_{450} system, such as warfarin, antipyrine, indomethacin, ibuprofen, phenytoin, propranolol, prednisone, diazepam, clarithromycin, or terfenadine in healthy subjects. These compounds are metabolized through various cytochrome P_{450} isozymes including CYP1A2, CYP2C9, CYP2C19, CYP2D6, and CYP3A. When lansoprazole was administered concomitantly with theophylline (CYP1A2, CYP3A), a minor increase (10%) in the clearance of theophylline was seen. Because of the small magnitude and the direction of the effect on theophylline clearance, this interaction is unlikely to be of clinical concern. Nonetheless, individual patients may require additional titration of their theophylline dosage when lansoprazole is started or stopped to ensure clinically effective blood levels.

Lansoprazole has also been shown to have no clinically significant interaction with amoxicillin.

In a single-dose crossover study examining lansoprazole 30 mg and omeprazole 20 mg each administered alone and concomitantly with sucralfate 1 gram, absorption of the proton pump inhibitors was delayed and their bioavailability was reduced by 17% and 16%, respectively, when administered concomitantly with sucralfate. Therefore, proton pump inhibitors should be taken at least 30 minutes prior to sucralfate. In clinical trials, antacids were administered concomitantly with PREVACID Delayed-Release Capsules; this did not interfere with its effect.

Lansoprazole causes a profound and long-lasting inhibition of gastric acid secretion; therefore, it is theoretically possible that lansoprazole may interfere with the absorption of drugs where gastric pH is an important determinant of bioavailability (eg, ketoconazole, ampicillin esters, iron salts, digoxin).

Carcinogenesis, Mutagenesis, Impairment of Fertility

In two 24-month carcinogenicity studies, Sprague-Dawley rats were treated orally with doses of 5 to 150 mg/kg/day, about 1 to 40 times the exposure on a body surface (mg/m^2) basis, of a 50-kg person of average height (1.46 m^2 body surface area) given the recommended human dose of 30 mg/day (22.2 mg/m^2). Lansoprazole produced dose-related gastric enterochromaffin-like (ECL) cell hyperplasia and ECL cell carcinoids in both male and female rats. It also increased the incidence of intestinal metaplasia of the gastric epithelium in both sexes. In male rats, lansoprazole produced a dose-related increase of testicular interstitial cell adenomas. The incidence of these adenomas in rats receiving doses of 15 to 150 mg/kg/day (4 to 40 times the recommended human dose based on body surface area) exceeded the low background incidence (range = 1.4 to 10%) for this strain of rat. Testicular interstitial cell adenoma also occurred in 1 of 30 rats treated with 50 mg/kg/day (13 times the recommended human dose based on body surface area) in a 1-year toxicity study.

In a 24-month carcinogenicity study, CD-1 mice were treated orally with doses of 15 to 600 mg/kg/day, 2 to 80 times the recommended human dose based on body surface area. Lansoprazole produced a dose-related increased incidence of gastric ECL cell hyperplasia. It also produced an increased incidence of liver tumors (hepatocellular adenoma plus carcinoma). The tumor incidences in male mice treated with 300 and 600 mg/kg/day (40 to 80 times the recommended human dose based on body surface area) and female mice treated with 150 to 600 mg/kg/day (20 to 80 times the recommended human dose based on body surface area) exceeded the ranges of background incidences in historical controls for this strain of mice. Lansoprazole treatment produced adenoma of rete testis in male mice receiving 75 to 600 mg/kg/day (10 to 80 times the recommended human dose based on body surface area).

Lansoprazole was not genotoxic in the Ames test, the *ex vivo* rat hepatocyte unscheduled DNA synthesis (UDS) test, the *in vivo* mouse micronucleus test or the rat bone marrow cell chromosomal aberration test. It was positive in *in vitro* human lymphocyte chromosomal aberration assays.

Lansoprazole at oral doses up to 150 mg/kg/day (40 times the recommended human dose based on body surface area) was found to have no effect on fertility and reproductive performance of male and female rats.

Pregnancy: Teratogenic Effects.
Pregnancy Category B

Lansoprazole

Teratology studies have been performed in pregnant rats at oral doses up to 150 mg/kg/day (40 times the recommended human dose based on body surface area) and pregnant rabbits at oral doses up to 30 mg/kg/day (16 times the recommended human dose based on body surface area) and have revealed no evidence of impaired fertility or harm to the fetus due to lansoprazole.

There are, however, no adequate or well-controlled studies in pregnant women. Because animal reproduction studies are not always predictive of human response, this drug should be used during pregnancy only if clearly needed.

Pregnancy Category C

Clarithromycin

See **WARNINGS** (above) and full prescribing information for clarithromycin before using in pregnant women.

Nursing Mothers

Lansoprazole or its metabolites are excreted in the milk of rats. It is not known whether lansoprazole is excreted in human milk. Because many drugs are excreted in human milk, because of the potential for serious adverse reactions in nursing infants from lansoprazole, and because of the potential for tumorigenicity shown for lansoprazole in rat carcinogenicity studies, a decision should be made whether to discontinue nursing or to discontinue the drug, taking into account the importance of the drug to the mother.

Pediatric Use

Safety and effectiveness in pediatric patients have not been established.

Use in Women

Over 800 women were treated with lansoprazole. Ulcer healing rates in females were similar to those in males. The incidence rates of adverse events were also similar to those seen in males.

Use in Geriatric Patients

Ulcer healing rates in elderly patients are similar to those in a younger age group. The incidence rates of adverse events and laboratory test abnormalities are also similar to those seen in younger patients. For elderly patients, dosage and administration of lansoprazole need not be altered for a particular indication.

ADVERSE REACTIONS

Clinical

Worldwide, over 6100 patients have been treated with lansoprazole in Phase 2-3 clinical trials involving various dosages and durations of treatment. In general, lansoprazole treatment has been well tolerated in both short-term and long-term trials.

The following adverse events were reported by the treating physician to have a possible or probable relationship to drug in 1% or more of PREVACID-treated patients and occurred at a greater rate in PREVACID-treated patients than placebo-treated patients:

Incidence of Possibly or ProbablyTreatment-Related Adverse Events in Short-term, Placebo-Controlled Studies

Body System/Adverse Event	PREVACID (N=1457) %	Placebo (N=467) %
Body as a Whole		
Abdominal Pain	1.8	1.3
Digestive System		
Diarrhea	3.6	2.6
Nausea	1.4	1.3

Headache was also seen at greater than 1% incidence but was more common on placebo. The incidence of diarrhea was similar between patients who received placebo and patients who received lansoprazole 15 mg and 30 mg, but higher in the patients who received lansoprazole 60 mg (2.9%, 1.4%, 4.2%, and 7.4%, respectively).

The most commonly reported possibly or probably treatment-related adverse event during maintenance therapy was diarrhea.

Additional adverse experiences occurring in <1% of patients or subjects in domestic trials are shown below. Refer to **Postmarketing** for adverse reactions occurring since the drug was marketed.

Body as a Whole - asthenia, candidiasis, chest pain (not otherwise specified), edema, fever, flu syndrome, halitosis, infection (not otherwise specified), malaise; *Cardiovascular System* - angina, cerebrovascular accident, hypertension/hypotension, myocardial infarction, palpitations, shock (circulatory failure), vasodilation; *Digestive System* - anorexia, bezoar, cardiospasm, cholelithiasis, constipation, dry mouth/thirst, dyspepsia, dysphagia, eructation, esophageal stenosis, esophageal ulcer, esophagitis, fecal discoloration, flatulence, gastric nodules/fundic gland polyps, gastroenteritis, gastrointestinal hemorrhage, hematemesis, increased appetite, increased salivation, melena, rectal hemorrhage, stomatitis, tenesmus, ulcerative colitis; *Endocrine System* - diabetes mellitus, goiter, hyperglycemia/hypoglycemia; *Hemic and Lymphatic System* - anemia, hemolysis; *Metabolic and Nutritional Disorders* - gout, weight gain/loss; *Musculoskeletal System* - arthritis/arthralgia, musculoskeletal pain, myalgia; *Nervous System* - agitation, amnesia, anxiety, apathy, confusion, depression, dizziness/syncope, hallucinations, hemiplegia, hostility aggravated, libido decreased, nervousness, paresthesia, thinking abnormality; *Respiratory System* - asthma, bronchitis, cough increased, dyspnea, epistaxis, hemoptysis, hiccup, pneumonia, upper respiratory inflammation/infection; *Skin and Appendages* - acne, alopecia, pruritus, rash, urticaria; *Special Senses* - blurred vision, deafness, eye pain, otitis media, taste perversion, tinnitus, visual field defect; *Urogenital System* - abnormal menses, albuminuria, breast enlargement/gynecomastia, breast tenderness, glycosuria, hematuria, impotence, kidney calculus.

Postmarketing

On-going Safety Surveillance: Additional adverse experiences have been reported since lansoprazole has been marketed. The majority of these cases are foreign-sourced and a relationship to lansoprazole has not been established. Because these events were reported voluntarily from a population of unknown size, estimates of frequency cannot be made. These events are listed below by COSTART body system.

Body as a Whole - anaphylactoid-like reaction; *Digestive System* - hepatotoxicity, vomiting; *Hemic and Lymphatic System* - agranulocytosis, aplastic anemia, hemolytic anemia, leukopenia, neutropenia, pancytopenia, thrombocytopenia, and thrombotic thrombocytopenic purpura; *Special Senses* - speech disorder; *Urogenital System* - urinary retention.

Combination Therapy with Amoxicillin and Clarithromycin

In clinical trials using combination therapy with PREVACID plus amoxicillin and clarithromycin, and PREVACID plus amoxicillin, no adverse reactions peculiar to these drug combinations were observed. Adverse reactions that have occurred have been limited to those that had been previously reported with PREVACID, amoxicillin, or clarithromycin.

Triple Therapy: PREVACID/amoxicillin/clarithromycin

The most frequently reported adverse events for patients who received triple therapy for 14 days were diarrhea (7%), headache (6%), and taste perversion (5%). There were no statistically significant differences in the frequency of reported adverse events between the 10- and 14-day triple therapy regimens. No treatment-emergent adverse events were observed at significantly higher rates with triple therapy than with any dual therapy regimen.

Dual Therapy: PREVACID/amoxicillin

The most frequently reported adverse events for patients who received PREVACID t.i.d. plus amoxicillin t.i.d. dual therapy were diarrhea (8%) and headache (7%). No treatment-emergent adverse events were observed at significantly higher rates with PREVACID t.i.d. plus amoxicillin t.i.d. dual therapy than with PREVACID alone.

For more information on adverse reactions with amoxicillin or clarithromycin, refer to their package inserts, **ADVERSE REACTIONS** sections.

Laboratory Values

The following changes in laboratory parameters for lansoprazole were reported as adverse events:

Abnormal liver function tests, increased SGOT (AST), increased SGPT (ALT), increased creatinine, increased alkaline phosphatase, increased globulins, increased GGTP, increased/decreased/abnormal WBC, abnormal AG ratio, abnormal RBC, bilirubinemia, eosinophilia, hyperlipemia, increased/decreased electrolytes, increased/decreased cholesterol, increased glucocorticoids, increased LDH, increased/decreased/abnormal platelets, and increased gastrin levels. Additional isolated laboratory abnormalities were reported.

In the placebo controlled studies, when SGOT (AST) and SGPT (ALT) were evaluated, 0.4% (1/250) placebo patients and 0.3% (2/795) lansoprazole patients had enzyme elevations greater than three times the upper limit of normal range at the final treatment visit. None of these patients reported jaundice at any time during the study.

In clinical trials using combination therapy with PREVACID plus amoxicillin and clarithromycin, and PREVACID plus amoxicillin, no increased laboratory abnormalities particular to these drug combinations were observed.

For more information on laboratory value changes with amoxicillin or clarithromycin, refer to their package inserts, **ADVERSE REACTIONS** section.

OVERDOSAGE

Oral doses up to 5000 mg/kg in rats (approximately 1300 times the recommended human dose based on body surface area) and mice (about 675.7 times the recommended human dose based on body surface area) did not produce deaths or any clinical signs.

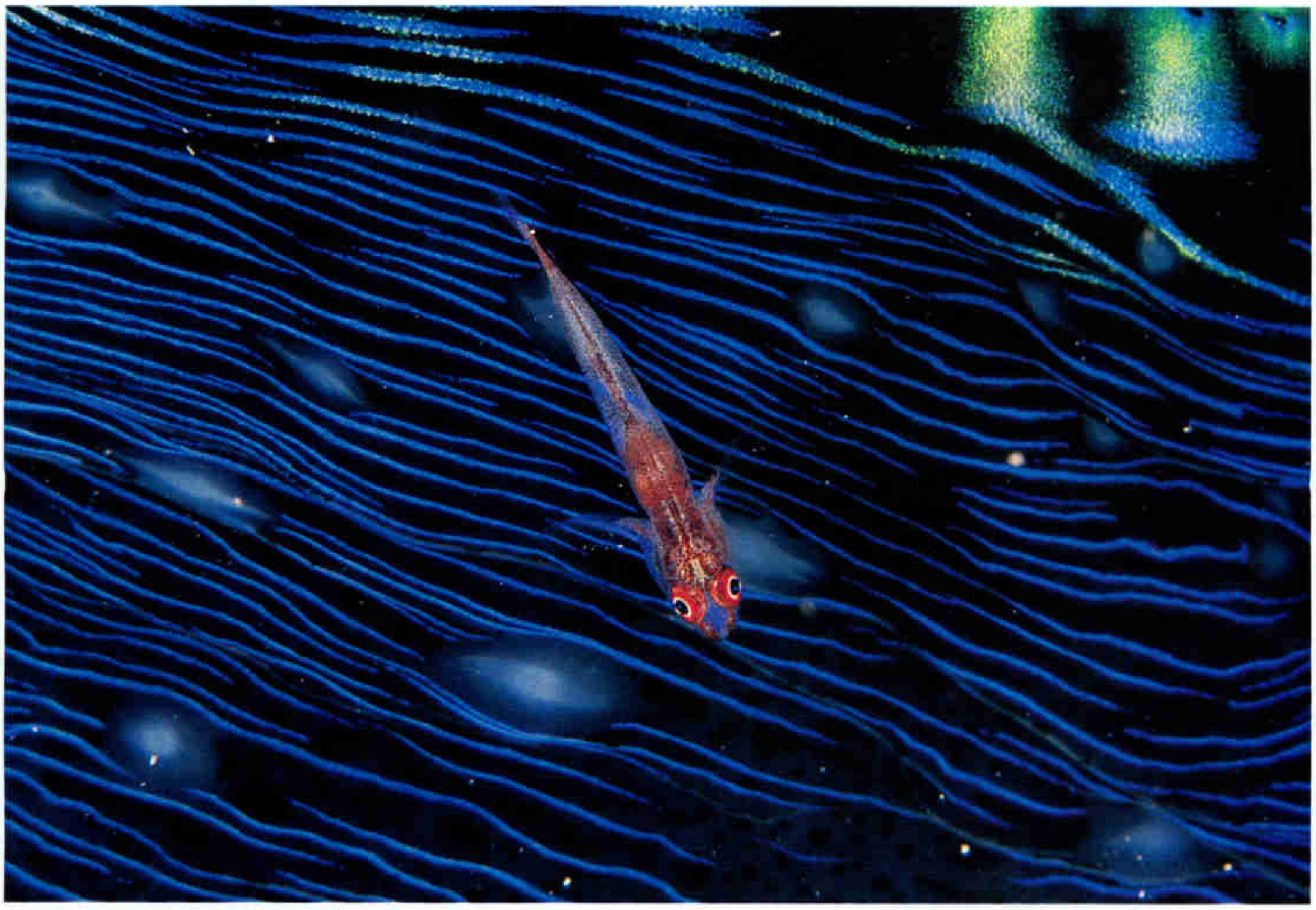
Lansoprazole is not removed from the circulation by hemodialysis. In one reported case of overdose, the patient consumed 600 mg of lansoprazole with no adverse reaction.

Manufactured for
TAP Pharmaceuticals Inc.
Deerfield, Illinois 60015-1595, U.S.A.
by Takeda Chemical Industries Limited,
Osaka, Japan 541

Ref. 03-5036-R14-Rev. March, 2000

For more detailed information, see Full Prescribing information or contact TAP Medical Services at 1-800-478-9526.

Final Edit



GREAT BARRIER REEF

A Goby's Velvet Garden

Minuscule blade of transparent life, a wide-eyed goby grazes on the wavy mantle of a giant clam in the waters of Australia's Great Barrier Reef. The mantle protrudes like lips from the scalloped edge of the open shell. Touched by filtered sunlight, it becomes a garden for algae, which produce nutrients that help feed the clam.

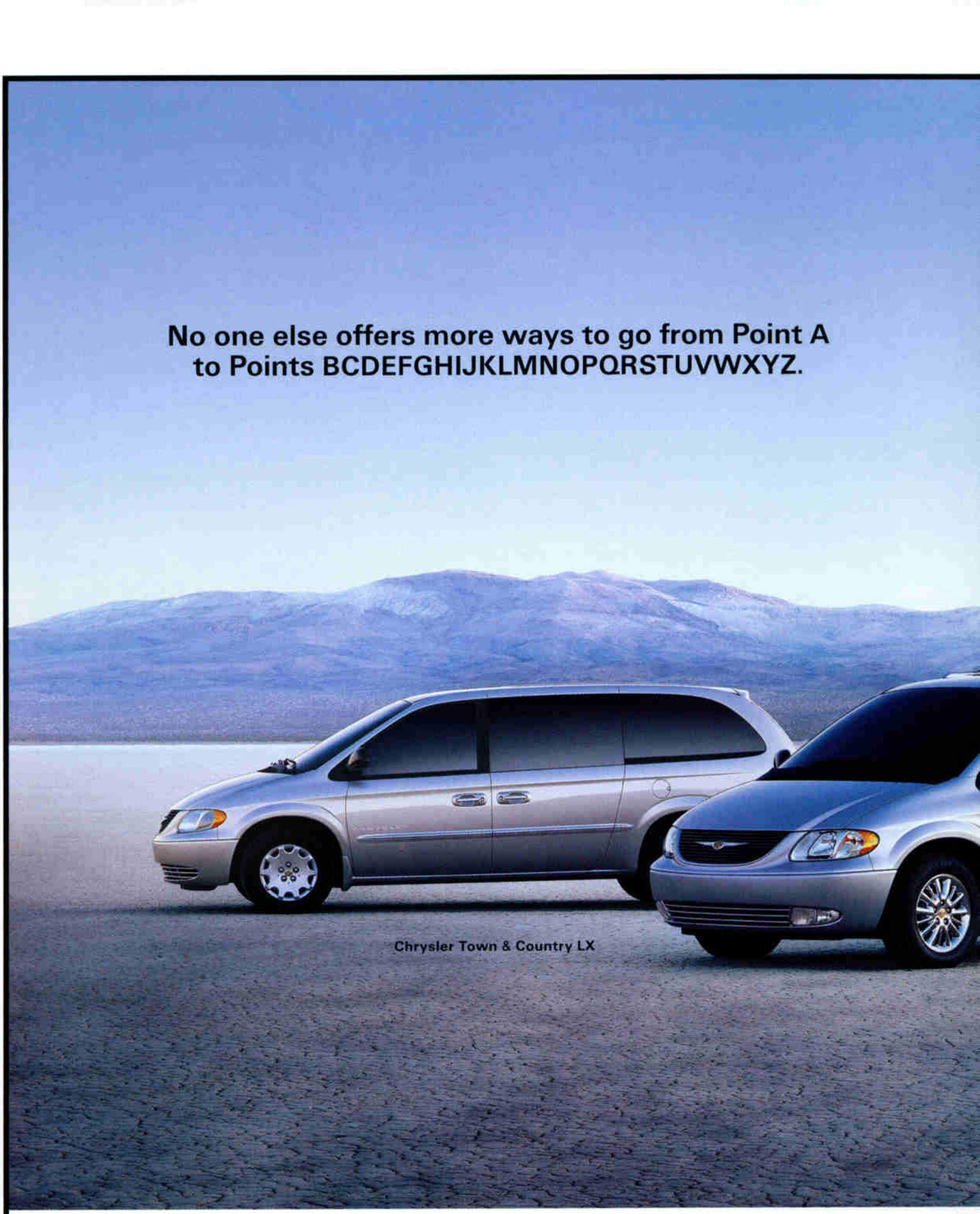
"On this particular mantle," says veteran underwater photographer David Doubilet, "the algae were colored in beautiful midnight and electric blues. And there was this little goby vacuuming detritus off the algae carpet, which had a pattern beyond what any weaver could imagine."

"What Doubilet does so well," says the story's designer, Elaine Bradley, "is to find something the average diver might never see and bring it to light."

MORE ON OUR WEBSITE

You can send this picture as an electronic greeting card at **nationalgeographic.com/ngm/finaledit/0101.**

No one else offers more ways to go from Point A to Points BCDEFGHIJKLMNOPQRSTUVWXYZ.



Chrysler Town & Country LX

CHRYSLER MINIVANS

We offer the largest selection of minivans,* from Chrysler Voyager to the height of luxury, Chrysler Town & Country Limited. Our next generation of minivans is re-engineered and redesigned to be the most innovative ever.**

*Based on comparison of body style by make. **Based on current and historic innovations combined.

Chrysler Town & Country Limited

Chrysler Voyager

So now there's a wide variety of ways to help you handle even the most ambitious to-do list–plus each and every possible point in between. For additional information, call 1.800.CHRYSLER or visit www.chrysler.com.

CHRYSLER

ON ASSI

ON THE ROAD, IN THE FIELD,

TOKYO

A Pair of Stars Is Born

The spirits of the King and the Chairman of the Board live on

CHIKAKO ISHIGURO

Like a butterfly emerging from its cocoon, a love of the spotlight may emerge from even the most mild-mannered individuals. Exhibit A: Executive Editor Robert Poole (above, at left) and staff photographer Sam Abell giving their all in a karaoke session while in Tokyo for their article on Japan's Imperial Palace.

"Those were stressful days," says Bob. "We worked long and hard, and karaoke was a way to unwind. I didn't look forward to it at first; nobody wants to make a fool of himself. But once we got started, it was hard to get the microphones out of our hands."

Joining Bob and Sam were Kaori Fujita, far left, associate editor of our Japanese-language edition, and Yoji Omura, a staff editor. "They made the story possible," Bob says. "It took time and a lot of hard negotiating to get access to parts of the palace that most people don't see. The access we got in the end was unprecedented."

The pair eventually perfected their karaoke routine, opening with "YMCA," then focusing on Elvis Presley, Nat King Cole, and Frank Sinatra. "Sam is a really good Sinatra," Bob notes.

Will Bob keep up his singing career? "Only in Tokyo," he says, "and only with people I know."

ALOFT OVER CHKALOVSKY AIR FORCE BASE, RUSSIA

Walking on Air

A few moments without the benefit of gravity

"Make yourself like stick," Russian Air Force Maj. Boris V. Naidyonov (below, in uniform) told author Michael E. Long on an Ilyushin-76 MDK flight that produced weightlessness. "I put my arms out, stiffened my legs, and began rising like Superman," Mike recalls. "You're sitting there one minute, levitating the next. Evolution doesn't prepare you for flying."

A former Marine jet pilot who has flown aircraft up to and including a Boeing 747, Mike regards a mission to Mars as the ultimate adventure. •

MARSEL GUBAIDULLIN

DAVID DOUBILET

GREAT BARRIER REEF

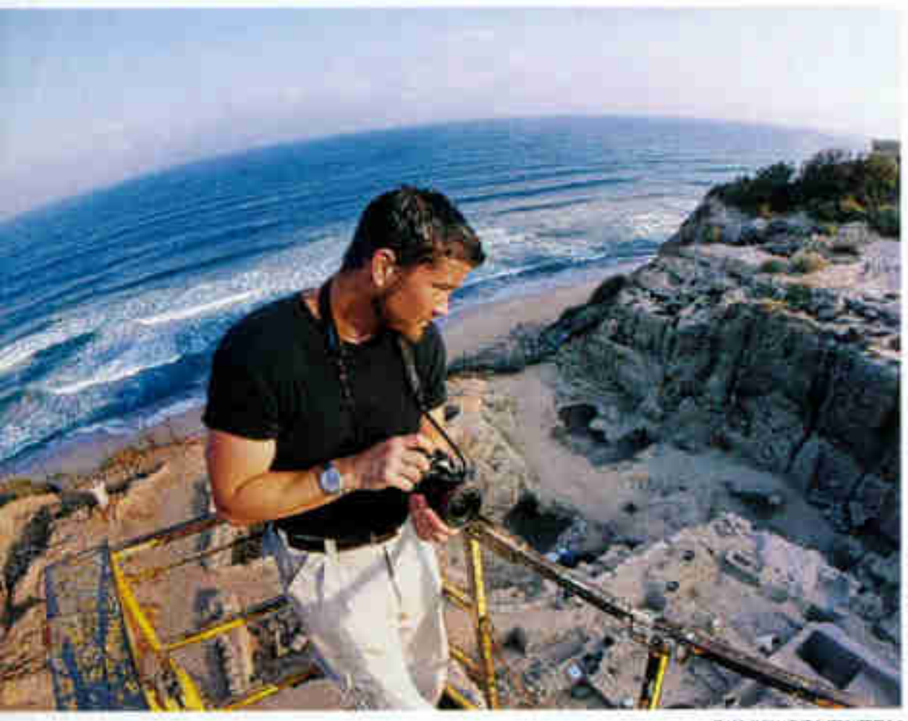
A Family Affair Way Down Under

"It was like breathing pure adventure down there," says author Douglas Chadwick (above, at left) of diving off the Australian coast. At one point a potato cod joined Doug, his family, and divemaster Duncan Johnstone, far right. Doug's wife, Karen Reeves, and their 16-year-old son, Russell Chadwick, shared the reef's wonders with Doug, though daughter Teal, at college, missed the trip. "The ultimate for a writer is to do this with the people you love the most," Doug says, "but at one point, when I looked back to see my wife and son circled by about 16 sharks, I devoutly wished I were doing a story on shopping malls in the U.S. Midwest."

This was the fourth GEOGRAPHIC article for which Doug, a wildlife biologist, has gone diving. "I was an old mountain goat biologist, and suddenly I'm this marine guy," he says.

WORLDWIDE

Rising to new heights atop a cherry picker, photographer **Robert Clark** surveys the dig at Ashkelon (below). "My job is to get readers off the couch and put them on the site," he says. Working on an archaeological story, he looks for the "personality" of the artifacts he shoots. "It's like finding the best angle of a person's face, except the objects are so small," says Robert. Ashkelon had one big advantage: "You get dirty and hot, but you're right on a Mediterranean beach."



DAVID COVENTRY

Vincent Musi paid a return visit to Philadelphia to photograph the annual Mummers Parade; he first shot the extravaganza on his own in 1993. "I spent a lot of time with the Mummers and got a lot of help from them," he says. "They put down all their rivalries to help me." Mummers take the parade very seriously, he notes. Last New Year "everyone was worrying about whether the world would close down for Y2K, but it made no difference to these guys."

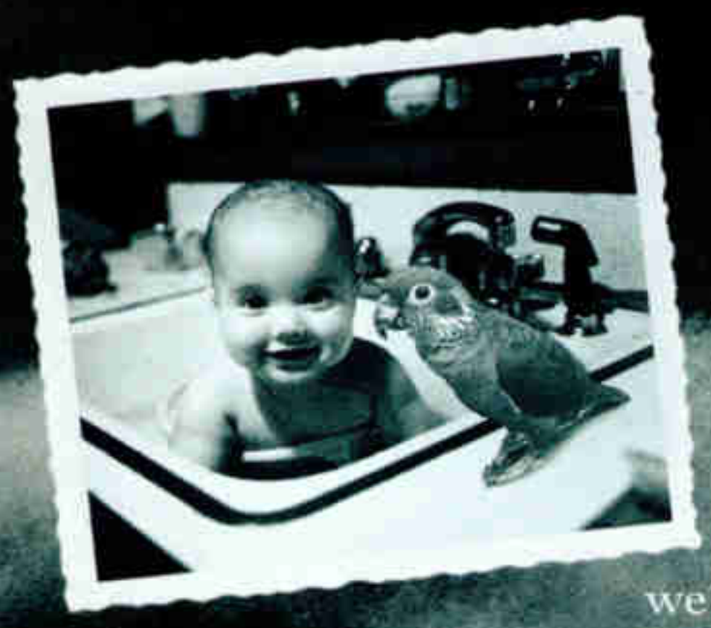
Who better to write about long-term space flight for our first issue of 2001 than **Arthur C. Clarke**, co-creator with Stanley Kubrick of *2001: A Space Odyssey*. An early space enthusiast, Sir Arthur —he was knighted in 1998 for "services to literature"—proposed the idea of communications satellites in 1945. "I remain an optimist," he has said, "especially in my fiction; I hope it may operate as a self-fulfilling prophecy."

MORE ON OUR WEBSITE

Find more stories about life on assignment at **nationalgeographic.com/ngm/0101**.

KAYTEE®

With the right diet,
"Friends Forever" may not
be an exaggeration.



He's always been by your side.
And over the years, his companionship
has become more important to you
than most people understand. Luckily,
we're not most people. Here at Kaytee
we're just as dedicated to keeping birds
happy and healthy as you are. That's why we're leading the way in
nutrition and innovation. Just look at the ingredients in Forti-Diet®.
You'll see we took special care to include everything your best
friend needs. And when you give him the best nutrition, you're not
only showing him how much you care, you're ensuring that he
really will be your lifelong friend.

1-800-KAYTEE-1 kaytee.com

KAYTEE–the leader in premium foods for pet birds, small animals and wild birds.

Flashback

B. ANTHONY STEWART

SURVIVING IN SPACE

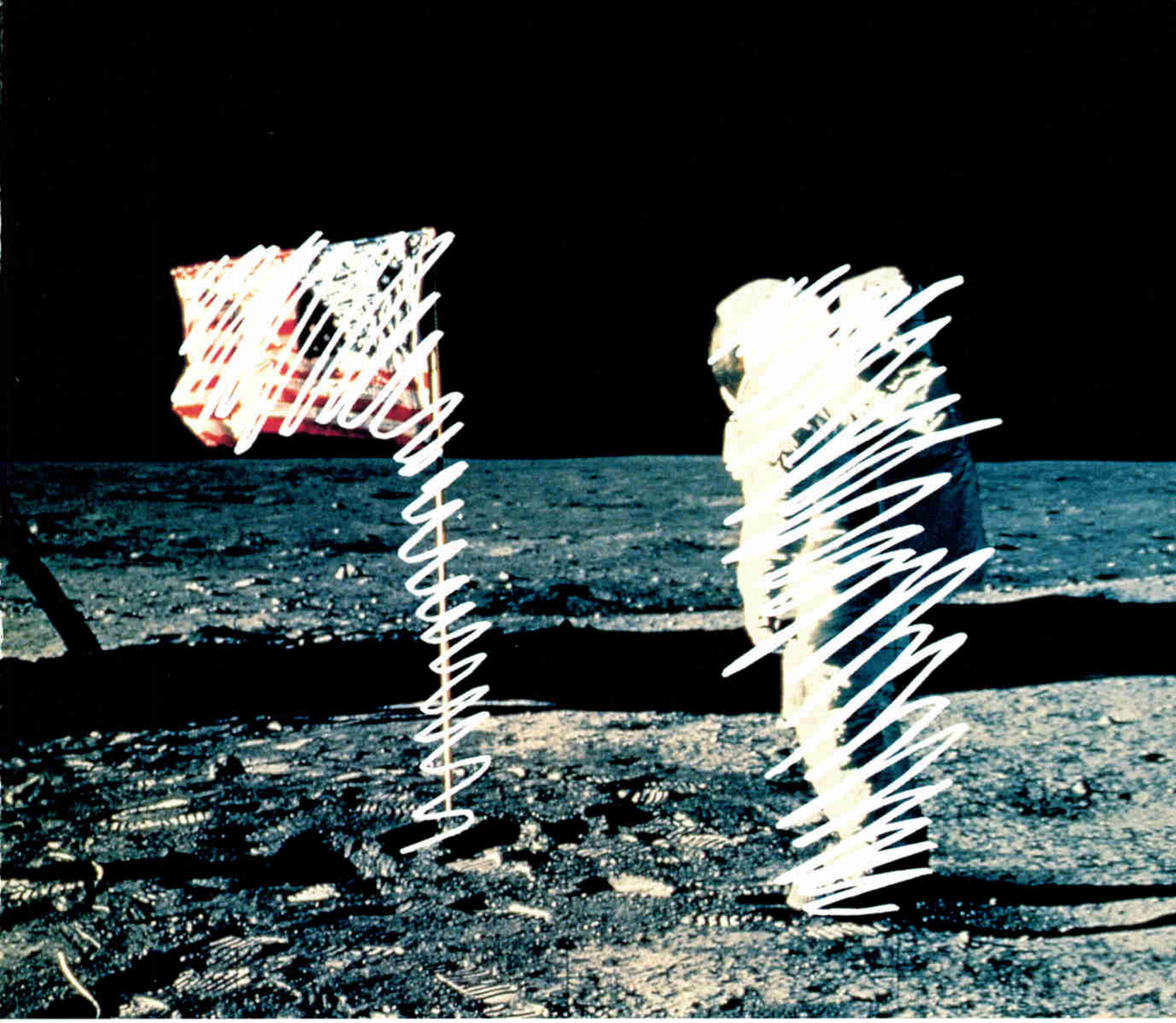
Rocket Science

Fedoras firmly planted, technicians from Robert H. Goddard's Roswell, New Mexico, workshop transport pieces of a rocket to its launch site in January 1940. GEOGRAPHIC staff writer McFall Kerbey carries the nose cone. Goddard—the father of modern rocketry—had been persuaded by his friend Charles Lindbergh to allow the magazine access, but every launch that winter witnessed by Kerbey and photographer B. Anthony Stewart ended in failure. The article was eventually canceled, and Stewart's photographs of Goddard's earthbound rockets, including this one, were never published in the magazine.

MORE ON OUR WEBSITE

You can find this image as well as access the Flashback photo archives at **nationalgeographic.com/ngm/flashback/0101.**

NATIONAL GEOGRAPHIC (ISSN 0027-9358) IS PUBLISHED MONTHLY BY THE NATIONAL GEOGRAPHIC SOCIETY, 1145 17TH ST. NW, WASHINGTON, DC 20036-4688. $29.00 A YEAR FOR U.S. DELIVERY, $5.00 PER SINGLE COPY (INCLUDES POSTAGE AND HANDLING). PERIODICALS POSTAGE PAID AT WASHINGTON, DC, AND AT ADDITIONAL MAILING OFFICES. POSTMASTER: SEND ADDRESS CHANGES TO NATIONAL GEOGRAPHIC, PO BOX 63002, TAMPA, FL 33663-3002.



Astronaut Buzz Aldrin, Apollo 11 Mission TM/©2000 Buzz Aldrin Licensed By Global Icons, L.A., CA 90034. All Rights Reserved.

THE GREATEST RISK IS NOT TAKING ONE.

They do not write the stories of those who played it safe. But that doesn't mean you should leap blindly, either. You can go after your idea with fiery determination, armed with the confidence of knowing you have chosen a business partner wisely. One with enormous resources. Vast imagination. One with the flexibility to custom-tailor solutions, no matter what the risk, no matter where the risk. Even if it's some crazy idea, like walking on the moon. So the next time you feel like trying something nobody has tried before, look no further than the organization that helps launch big ideas every day.

WORLD LEADERS IN INSURANCE AND FINANCIAL SERVICES

Insurance and services provided by members of American International Group, Inc., 70 Pine Street, Department A, New York, New York 10270.

AIG

WWW.AIG.COM

100% Uplifting.

TOUR SPONSOR
FIS
ALPINE SKI WORLD CUP

Café de Colombia
It's the world's cup.™